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Three novel games of information and competition: Exploring human strategic reasoning

By

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List of Figures

List of Tables

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Declaration

This thesis is submitted to the University of Warwick in support of my application for the degree of Doctor of Philosophy. It has been composed by myself and has not been submitted in any previous application for any Degree.

The work presented (including programming, data collection and analysis) was carried out by the author.

Abstract

This thesis introduces three novel competitive games that fill the gaps between games of perfect information and games of imperfect information. Each game has a common underlying structure with small, but crucial, differences. Concretely, each game has trials in which dominance should be respected and trials where trickery attempts are possible. Furthermore, we focus on risk attitude (Envelope Game); explore reasoning processes through verbal protocols (Transfer Game); and assess the effects of additional information (Suitcase Game). Behavioural experiments show that even these simple games are cognitively very challenging and that behaviour often deviates from the predictions of popular frameworks. The main contributions from this thesis are (a) the creation of three novel games that help fill the gaps between perfect information and imperfect information; and (b) the exploration of these games and their implications. Findings from the first experiment indicate a linear relationship between the willingness to transfer value from Option A to Option B and a higher initial value for Option A. We also found that decision times for player one reflect which choices he contemplates whilst decision time for player two does not relate to her choices. Finally, most participants are assessed as risk averse. When larger amounts are involved a risk averse player one more strongly desires to transfer value compared with a non-averse player one; but we do not find any behavioural differences for player two. From our second experiment we learn that participants are often not consistent in their reasoning and behaviour across trials. Despite the simplicity of the game we observe many violations of dominance. Furthermore, participants do not strongly adhere to a specific framework. Using verbal protocols we learn about the reasoning that is used to make decisions. This procedure also identified a weakness of the design: participants often consider small amounts irrelevant (since they barely affect payoffs). Our third experiment focuses on the effect of additional knowledge. We find evidence that equal divisions are made more frequently when additional knowledge is provided and that participants attempt to trick their opponents. Furthermore, we explore whether heuristics can explain behaviour since frameworks are often too precise or make 'random behaviour' predictions.

Key Words: Game Theory, Sequential, Constant-Sum, Information Asymmetry, Bluffing, Dominance, Risk Attitude, Verbal Protocols.

List of Abbreviations

AV: Announced Values. The AVs are two amounts which are provided to the participants in the Suitcase Game. Participants are aware that one of these two amounts is placed inside the suitcase and that the two amounts are equally likely.

BS: Big to Small directionality. When a transfer is suggested in the Transfer Game we assign a BS-directionality if the transfer goes from the box with 40 tokens to the box with 80 tokens.

Box A: The physical screen location of the boxes in the transfer game. Left Box.

Box B: The physical screen location of the boxes in the transfer game. Right Box.

CCG: Cake Cutting Game.

CE: Closed Envelope. One of the three envelopes found in the Envelope Game.

Chooser: Player two in our three experimental games is also known as the Chooser.

DA: Distribution Amount. The amount that is found in the suitcase is sometimes referred to as the Distribution Amount given that it is to be distributed between the table and the suitcase.

DE: Destroyed Envelope. One of the three envelopes found in the Envelope Game.

DF: Direction From. A term used in the Transfer Game to refer to the pay-off option from which value can be transferred.

DT: Direction To. A term used in the Transfer Game to refer to the pay-off option to which value can be transferred.

Decider: Player one in the transfer game is also known as the Decider.

EV: Expected Value.

EP: Expected Pay-off. A subscript may be added to refer to Player One / Player Two

FP: Fictitious Play. An Algorithm designed by Brown (1951) which involves an iterative method in which one keeps track of past choices to select the option with the highest expected value based on past behaviour.

L: Large AV (Announced Value).

MDA: Mean Distribution Amount.

OE: Opened Envelope. One of the three envelopes found in the Envelope Game.

Opener: Player one in the envelope game is also known as the Opener.

Option A: the option from which value can be transferred. In each game this option has a unique name (i.e. Opened Envelope, Box A, Suitcase).

Option B: the option from which value can be transferred. In each game this option has a unique name (i.e. Closed Envelope, Box B, Table).

P1: Player One.

P2: Player Two.

PBNE: Perfect Bayesian Nash Equilibrium.

RA: Risk Averse.

RN: Risk Neutral.

RS: Risk Seeking.

S: Small AV (Announced Value).

SB: Small to Big directionality. When a transfer is suggested in the Transfer Game we assign an SB-directionality if the transfer goes from the box with 80 tokens to the box with 40 tokens.

SONA: an online system used to recruit participants for experiments.

Splitter: Player one in the suitcase game is also known as the Splitter.

SPP: Sealed Package Paradigm.

UG: Ultimatum Game.

WTP: Willingness To Pay.

Chapter 1 Introduction

1.1 Background

In everyday life we face numerous occasions in which outcomes depend on the interaction of choices. The winner of a game of chess is decided through the interactions between the black player and the white player. The result on a maths exam is decided by both the knowledge, topics revised and overall level of effort put in by the student and by the concrete exam questions that the teacher selected. These examples involve a social dance or game in which individual agents aim for specific outcomes based on their knowledge and assumptions. They are ideal for analysis by the field of game theory in which we convert the formal and logical properties of strategic scenarios into abstract forms which we refer to as ‘games’. The decision maker becomes a ‘player’ and his choices are referred to as ‘moves’.

Colman (1982) defined the field of game theory as followed:

> *“Game theory is concerned with the logic of decision making in social situations in which the outcomes depend upon the decisions of two or more autonomous agents. An essential feature of such situations is that the decision maker only has partial control of the outcomes.”*

In essence, game theory studies strategic interactions. Traditional game theory is highly mathematical and aims to provide a normative account of how rational agents should behave when interacting with other rational agents. Concretely, rational players are assumed to make choices that lead to an equilibrium state (Seidenfeld, 2001). Their aim is to make a best response against the strategy that their opponent plays. In this context a ‘best response’ is defined as a strategy choice which leads to the most favourable outcome against the anticipated strategy played by the opponent. We reach a Nash equilibrium whenever the best response strategies intersect – in such a state neither player can gain by unilaterally changing their strategy.

Over the years the field has expanded enormously and now addresses logic and strategic interactions in many disciplines including economics, animal behaviour, evolutionary theory, and psychology. However, even in simple games people behave differently from what is expected by standard theory. The Prisoner's Dilemma provides a good example (See Figure 1).

Figure 1: Example Prisoners Dilemma

	Confess	Plead Innocence
Confess	2, 2	0, 3
Plead Innocence	3, 0	1, 1

The numbers in this figure represent years in jail; thus lower numbers are preferred. Regardless the decision made by the other player it is always better to confess since it leads to less jail-time.

In the Prisoner's Dilemma two players make a binary choice by deciding to confess a crime versus plead innocence. The game is designed such that players receive a better pay-off from confessing than from pleading innocence – regardless what the other player does. For this reason it is called a "dominant strategy". However, the dilemma lies in the fact that mutual confession has a worse pay-off than mutual pleading of innocence (Binmore, 2007). Nash predictions are that both players choose their dominant strategy but observations often show coordination on pleading innocence.

Furthermore, many experiments show that participants do not reason too deeply. A classic example is the Beauty Contest Game (Nagel, 1995) in which participants write down a number between 0 and 100. Whoever wrote down the number closest to a predefined fraction of the average estimate (e.g. $F = \frac{2}{3}$) wins the game (Camerer, Ho and Chong, 2004). When the winner is the person whose number is closest to two thirds of the average number it can be deduced that numbers larger than 66 are never the best response. After all one should never guess more than two thirds of the maximum amount ($100 \times \frac{2}{3} \approx 66$) even when all the other players guess the maximum number. However, if the assumption is made that other players reach this conclusion then the maximum number to expect from opponents is no longer 100 but 66. Using the same logic as before one should never guess more than two thirds of this new maximum value: i.e. one should never guess more than 44. Given that other players reach the same conclusion over and over the end result from backwards induction is that every player should guess 'zero'. This is the best response against the best response of everyone else and hence forms the Nash equilibrium for this game (Duffy & Nagel, 1997). Instead, participants reason about the task up to a certain level (typically one or two steps). There are many limitations to deal with when reasoning about a game (e.g. knowledge, difficulty, time constraints) and players are not always fully rational as is assumed in standard game theory – they act under “bounded rationality”. Players do not look for the best solution; they simply look for a *satisficing* one (Simon, 1972). Due to such behavioural departures from standard theory it became essential to modify the theory and to look at observations and behaviour. The field of behavioural game theory was created to experimentally test how people behave in the same strategic interactions that are studied by mathematical game theory and by formulating theories of formal interactions. We focus on choices made in experiments and realize that such choices are not always fully rational.

In this thesis we explore behaviour in three different experiments and we use additional techniques to see why choices are made and how participants reason about their task. Furthermore, we are interested in topics such as risk attitudes, bluffing behaviour and whether dominant choices are acknowledged.

1.2 Basic concepts in game theory

Before we introduce the reader to the design of our experimental games we discuss some common terminology. We distinguish between sequential and simultaneous games; subdivide sequential games into games of perfect versus imperfect information; and divide games of imperfect information into symmetrical versus asymmetrical games. Finally, we distinguish between games with complete versus incomplete information.

Simultaneous games are those in which players decide upon their strategy at the same time or at least without knowledge on the strategy chosen by the other player. Games such as Rock-Paper-Scissors are good examples. In sequential games, choices are made turn based; furthermore, players are provided with some knowledge regarding the moves made by players who were earlier in the sequence. An example is chess: the white and black player take turns and have knowledge on the moves made by their counterpart. Sequential games can be subdivided into games of perfect versus imperfect information. Games of perfect information are sequential designs in which you observe the moves made by all other players (this includes ‘nature’ as a potential player). Chess is still a valid example since both the white and the black player observe all the moves that are made by their counterpart. Games of imperfect information are sequential designs in which not all the moves are observed by all players. Poker is an example since players do not know which cards their opponents hold in their hand (which is decided by ‘nature’). Sequential games with imperfect information can be further divided as games with symmetric information versus asymmetric information. Symmetrical information games are those in which both players know equally much (e.g. poker) whilst asymmetrical information games are those where one player has more information than another player (e.g. buyers often know less than sellers). Finally, we distinguish between the concepts of complete and incomplete information. Complete information implies that players know the full structure of the game and the corresponding pay-offs[1]; when this is not the case we speak of incomplete information. Poker is a game of complete information (since the structure of the game and pay-offs are known) whilst an example of a game of incomplete information is found in scenarios where participants are not aware of the full rules of the game they play (e.g. someone who learns a new board game can be caught off guard by not realising alternative “victory conditions”).Table 1 summarizes these concepts.

Table 1: Basic Concepts related to Experimental Design

Concept	Definition
Simultaneous Design	Players make their decisions simultaneously. E.g. rock-paper-scissors.
Sequential Design	Players make their decisions sequentially. Having such a sequence allows players to have knowledge on the decisions of players who are earlier in the sequence. A subdivision can be made into perfect versus imperfect information. E.g. chess.
Perfect Information	This is a sequential design in which all players observe all previous moves made by all other players (note that nature is considered a player as well). E.g. chess.
Imperfect Information	This is sequential design in which not all players observe all the previous moves made by all players (note that nature is considered a player as well). E.g. Poker.
Symmetric Information	This is a sequential design with imperfect information in which all players have the same degree of (limited) information. E.g. Poker.
Asymmetric Information	This is a sequential design with imperfect information in which some

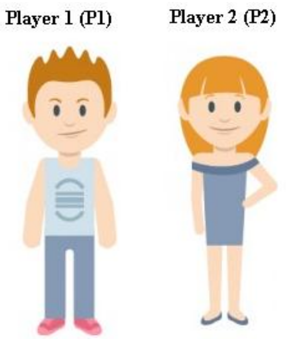
[1] And the assumption is made that everyone knows that everyone has complete information.
[2] Note that we did not use these images (nor the ‘he’ versus ‘she’ terminology) during our

	players have more information than others. E.g. the buyer often knows less about a good than the seller.
Complete Information	Players know the full structure of the game and the related pay-offs for each player. An additional assumption is made that all players know that all players have complete information. E.g. Poker.
Incomplete Information	Whenever Players do not know the full structure of the game and its related pay-offs we speak of Incomplete Information. E.g. a novice player who is not aware of alternative victory conditions operates under incomplete information since he does not fully grasp the structure of the game he plays.

1.3 Design of our games

We designed three novel competitive games that allow natural phenomena such as bluffing behaviour to occur in a simple set-up. Each game involves two players whom we refer to as Player One (P1) and Player Two (P2). In the remainder of this thesis we consistently depict P1 as a male and P2 as a female character[2] (see Figure 2). Furthermore, we consistently use 'green' colours for P1-actions and 'blue' colours for P2-actions.

Figure 2: Depicting P1 and P2



Throughout this thesis we represent P1 and P2 with these characters. Furthermore, we consistently assign a male gender to P1 and a female gender to P2 to minimize ambiguity.

The three games are sequential games with complete but (asymmetrically) imperfect information. They involve complete information since players know the structure and corresponding pay-offs. And it is played sequentially with a consistent knowledge deficit for the second player implying asymmetric information.

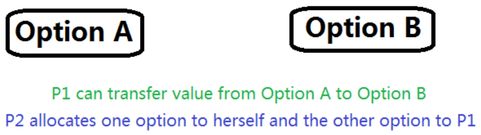
Furthermore, each game involves a constant-sum design which means that the gains of the individual players sum together to the same constant value regardless the choices that are made – choices merely affect how the 'sum' is divided between

[2] Note that we did not use these images (nor the 'he' versus 'she' terminology) during our experiments; it is used in this thesis to minimize ambiguity for the reader.

the players. This implies that the game is strictly competitive since one player's gains correspond to the other player's losses. Concretely, each experimental trial involves the division of a constant value into two segments which we abstractly refer to as 'Option A' and 'Option B'. P1 can affect the value of the two segments by making a value-transfer from Option A to Option B; whilst P2 decides which player receives which option as their pay-off. Since choices are made sequentially, P2 knows how much value (if any) is transferred from Option A to Option B (see

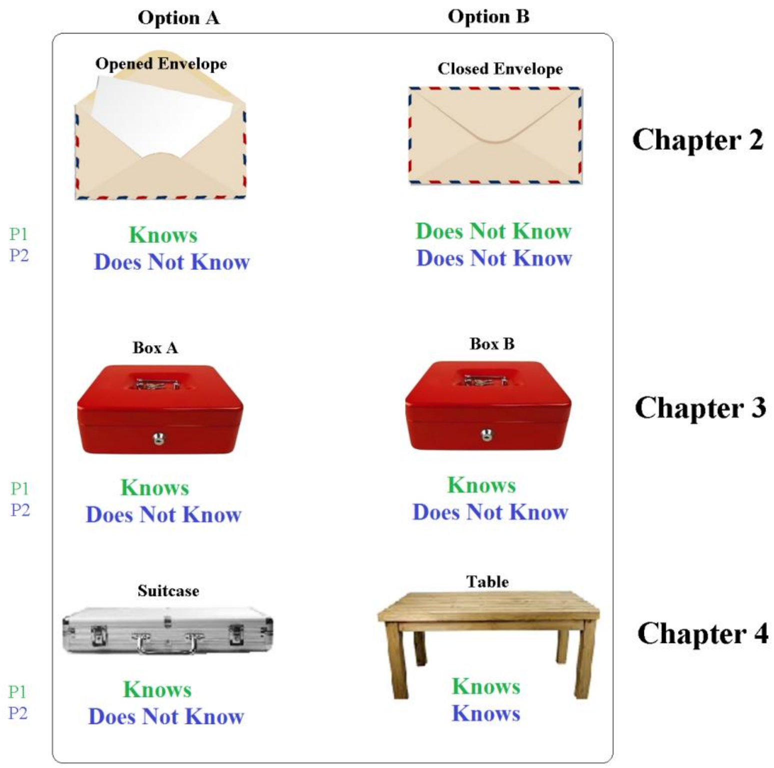
Figure 3 for an overview of shared features between the three games).

Figure 3: Skeleton Features shared by our three games



Each of our three experimental games is framed in a different way. Furthermore, the games differ in terms of their knowledge structure regarding the two options; which lets us explore the gaps between games of perfect information and games of imperfect information (see Figure 4).

Figure 4: The knowledge structure of our three games



This figure provides an overview of the knowledge structure of our three experimental games. Players either know the numerical value of an option or they do not know the value. Furthermore, it illustrates framing differences and indicates the corresponding chapters.

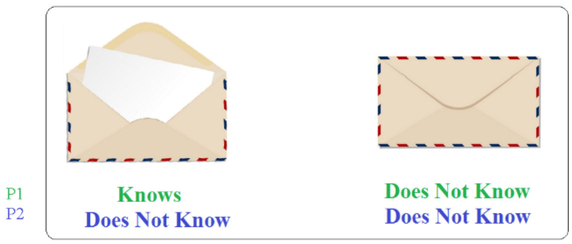
In the Envelope Game (Chapter 2) Option A and Option B are framed as two ‘Envelopes’; it is set-up such that P1 solely knows the value of Option A whilst P2 does not know the value of either option. In the Transfer Game (Chapter 3) Option A and Option B are framed as two ‘Boxes’; the set-up is such that P1 knows the value of both options whilst P2 does not know the value of either option. Finally, the Suitcase Game (Chapter 4) is framed as a ‘Suitcase’ (Option A) and a ‘Table’ (Option B); here, P1 knows the value of both options whilst P2 only knows the value of Option B. Each of these games involves information asymmetry with a more knowledgeable P1 – this is essential for the games to be viable (i.e. since P2 allocates the options it is essential that P1 has the information advantage).

In this thesis we explore how game theory analyses these games and what preliminary results can be found experimentally. Furthermore, we look at more recent behavioural approaches such as level k reasoning. The next three subsections explain the games in more details and elaborate on additional background knowledge that is included in the individual games.

1.3.1 Envelope Game

The first game is framed in terms of Envelopes that contain valuable coins. Participants are told that each envelope contains at minimum two coins and that the sum of the envelopes is exactly twelve coins. Furthermore, P1 knows the content of one of the two envelopes (which we later refer to as the Opened Envelope) whilst P2 does not know the content of either envelope (see Figure 5).

Figure 5: Knowledge structure in the Envelope Game



One minor adjustment was needed to the design to keep the desired knowledge structure intact. When the game is played with two envelopes it is easy for P1 to deduce the value of the closed envelope – since he already knows the value of the opened envelope and the summed value of the two envelopes. For this reason each trial starts off with three envelopes (each containing at minimum two coins and their total sum being exactly twelve coins) and one of them is randomly destroyed without revealing its value. Thus, P1 cannot deduce the value of the closed envelope.

The task for P1 is to transfer coins from the opened envelope to the closed envelope – which may be any (integer) amount including zero and the full value of the opened envelope. P2 knows how many coins are transferred but does not know the original content of either envelope. Her choice is to allocate one of the envelopes to herself whilst the remaining envelope is given to P1.

1.3.2 Transfer Game

The Transfer Game has a similar design as the Envelope Game but does not need a third option to maintain its knowledge structure. This experiment uses the framing of two boxes and has tokens as its currency[3]. Participants know that every trial involves two boxes one of which contains 40 tokens whilst the other contains 80 tokens. The knowledge structure is such that P1 knows which box contains the 40 versus 80 tokens whilst P2 does not have this knowledge (see Figure 6).

Figure 6: Knowledge structure in the Transfer Game

The task is in many ways the same as in the Envelope Game. P1 can transfer tokens from Option A to Option B whilst P2 allocates each player with one box. However, given that each trial consists of one box with 40 tokens and one box with 80 tokens we now predefine the transfer amount – since the game is otherwise

[3] Note that whenever tokens are used as currency this means that participants are not aware of the stakes of their choices. In the Envelope Game they knew how much a coin was worth; but in the other two experiments they have no knowledge regarding the value of their tokens.

limited to two recurring scenarios for P1[4]. This means that P1 no longer chooses how many tokens to transfer: he simply decides whether to make the transfer that is suggested to him. Concretely, P1 sees the value of the two boxes and is informed about the potential transfer amount; he either makes this transfer or he does not transfer. P2 knows how many tokens could have been transferred and whether this transfer was made. As before, she allocates one option to herself and the other option to P1.

1.3.3 Suitcase Game

The Suitcase Game is our third and final design. Similar to the Transfer Game tokens are used as currency and P1 knows the content of both options. Now, however, P2 also knows the content of Option B (see Figure 7). The game is framed in terms of a suitcase whose value is only known to P1 and a table amount that is known by both players.

Figure 7: Knowledge in the Suitcase Game

This game also deviates from its predecessors by providing additional knowledge in half of its trials. Concretely, the additional knowledge consists of two numerical values and one of them is guaranteed to be found in the suitcase (before P1 opens it); furthermore, participants know that both amounts are equally likely. In line with the previous games P1 can transfer tokens from the Suitcase (Option A) to the Table (Option B) and P2 knows how many tokens are transferred. Again, P2 decides who receives the table and who receives the suitcase by selecting her desired option. Similar to the Envelope Game P1 decides upon the transfer amount himself (since the suitcase value differs on every trial). Finally, it is worth mentioning that the Suitcase Game differs from the other games by initially having an empty table

[4] Either Option A is the box with 80 tokens which allows P1 to decrease the variance between the two options; or Option A is the box with 40 tokens which allows P1 to increase the variance between the two options.

amount (i.e. Option B has zero tokens at the start of each trial); this simplifies the task and should not affect theoretical predictions – this is viable in the Suitcase Game since both players know the value of the Table amount.

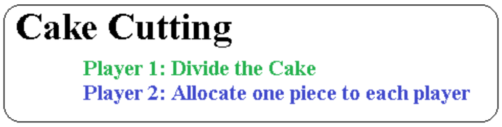
In the next section we introduce some relevant existing games and illustrate how they relate to our own design.

1.4 Experimental games in the literature

In this section we introduce the reader to existing experimental games with a relationship to our own design. Our focus lies on two-player sequential games. First, we introduce Cake Cutting Games and Ultimatum Games. Then we discuss modifications of the Ultimatum Game that involve information asymmetry. Finally, we discuss a game by Gneezy (2005) that explored deceitfulness in a somewhat similar design as our own games and an experiment by Van Dijk and Zeelenberg (2007) about conditional feedback, regret and curiosity which also uses a similar design.

The setup of Cake Cutting Games (CCG) is such that a resource (i.e. a "cake") is divided using a 'divide and choose' protocol for fair division (Chen, Lai, Parkes and Procaccia, 2013): P1 divides the cake into two parts whilst P2 decides who receives which part of the cake (see Figure 8).

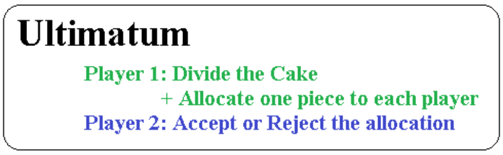
Figure 8: Cake Cutting Game (CCG): setup



Our own experiments can be seen as CCGs with different degrees of imperfect information. In each of our experiments P1 either divides the cake into two segments (suitcase game) or he is able to adjust an initial cake distribution (envelope and transfer game) whilst P2 allocates the cake-segments to the two players.

Another game of interest is the Ultimatum Game (UG). This is a sequential game with complete and perfect information. P1 divides a resource into two parts and decides on the allocation of the pieces to the players. P2 decides whether to accept or reject the suggested division (see Figure 9).

Figure 9: Ultimatum game (UG): setup



If P2 accepts the division then both players receive their allocated share. However, if she rejects the division then both players go home without any cake whatsoever (i.e. zero pay-offs). This implies that the UG is not constant-sum in nature, since P2's decision affects whether the individual pay-offs sum together to form the whole cake or whether the individual pay-offs sum to a value of zero cake. Economic theory suggests that P1 should offer the bare minimum to his opponent and that P2 should accept any division in which she receives a non-zero share (Güth, 1995; Thaler, 1988; Camerer & Thaler, 1995; Rubinstein, 2007). The UG differs from our own experimental games in three important ways. Firstly, the task for P2 in the UG is to agree or disagree to a proposed division of a monetary amount; in our own experimental games her task is to decide between the two options and choose whichever option she prefers. Secondly, the UG is not a constant-sum game whilst our own experiments all have a constant-sum nature. Finally, the UG involves perfect information whilst our games involve imperfect information and information asymmetry. However, it is worthwhile to point out that UG-variations have been explored in the context of imperfect information (e.g. Mitzkewitz and Nagel, 1993; Rapoport, Sundali and Seale, 1994; Croson, 1996). These variations are considered more like real life bargaining due to the typical information asymmetry in real life scenarios. Next, we introduce the reader to the Offer Game and Demand Game (which are variations of the UG) and explore the relationship between these games and our own designs.

The Offer Game is a modification on the UG in which P2 is aware of the value offered to her whilst she does not know what value is kept by P1. In essence when deciding whether to accept or reject a cake-division she only observes the slice of cake that is offered to her. The Demand Game explores the opposite scenario: here, P2 can see the slice of cake that is claimed by P1 but she does not know the size of the slice offered to her. Figure 10 summarizes the differences between the three versions.

Figure 10: Contrasting ultimatum, offer and demand games

Ultimatum Game
Player 2 knows what is offered to her
Player 2 knows what is kept by Player 1

Offer Game
Player 2 knows what is offered to her
Player 2 does not know what is kept by Player 1

Demand Game
Player 2 does not know what is offered to her
Player 2 knows what is kept by Player 1

This figure illustrates that differences between the offer, demand and ultimatum game involve the knowledge held by P2.

The Suitcase Game displays a strong similarity to the Offer Game. In the Suitcase Game, the table amount is known by both players whilst the suitcase amount remains a mystery; in the Offer Game the offered amount is known whilst the amount that is kept by P1 remains a mystery. The main difference between the games is the task given to P2 – in the Offer Game she either accepts or rejects the offer whilst in the Suitcase Game she decides between the offered amount on the table and the hidden amount in the suitcase. The Transfer Game and Envelope Game also have similarities with the Offer Game, however, they involve uncertainty for P2 about the exact offer – since the initial value of neither option is known to her in these games. It is worth mentioning that the distinction between the Offer and Demand game fades in our own set-up since P2 can choose whether to pick the cake-slice whose value is (partly) revealed versus the unrevealed slice.

Another game of interest involves deceitful signalling behaviour and is described by Gneezy (2005). In this game there are two potential outcomes. P1 knows the pay-offs that are associated to the two outcomes but P2 does not know these pay-offs (asymmetrical information). The game is set up such that P1 decides between sending a truthful message (i.e. "Option A will earn you more money than Option B") or a deceitful message (i.e. "Option B will earn you more money than Option A"). P2 receives the message and decides which outcome is realised. This experiment was run as a one-shot game (i.e. involving only one trial) in which participants faced one of three potential treatments (see Table 2).

Table 2: Treatments in Gneezy's experiment

	Option A	Option B
Treatment A	5, 6	6, 5
Treatment B	5, 15	15, 5
Treatment C	5, 15	6, 5

Treatments A and B involved constant-sum pay-offs (with big versus small pay-off differences); whilst Treatment C involved a potentially high pay-off for P2 with small pay-off differences for P1. In each treatment Player One would gain from a deceitful message (i.e. saying that Outcome B would give the second player a better pay-off than Outcome A), however, the consequences of deceit differ depending on the treatment and findings indicate that participants react differently in the three treatments. Downsides of the design are that it remains unclear why decisions are made and that P2 has incomplete information since she does not know the pay-off structure of the game[5]. Gneezy's design relates well to the transfer game since P1 knows the value of the two options whilst P2 picks between the options. However, instead of making a transfer P1 now sends a message; not all treatments have a constant-sum setup; and most importantly Gneezy's design involves incomplete information which makes it hard for P2 to assess whether or not her interests diverge from P1's interests. One reason why this game is worthwhile to mention is that the act of transferring value (in our games) can be seen as a signal. The opposing player may make a transfer because there was a big value in Option A; or he may make a transfer in attempt to 'trick' P2 into thinking that way.

Finally, we discuss the Sealed Package Paradigm (SPP) introduced by Van Dijk and Zeelenberg (2007). In this design participants made a one-shot decision between receiving 15 euro for certain versus a sealed package with unknown content. Two factors were manipulated namely feedback and additional information. Participants either learn what was in the sealed package regardless their decision (unconditional information) versus they learn the content of the sealed package only if they choose the sealed package (conditional information). Furthermore, participants either receive no additional information; or they know that the content of the sealed package is round; or they know that the content of the sealed package is

[5] The appendix of their experiment illustrates that the second player has no information whether a competitive or a cooperative game is played. This may be representative of real life scenarios to a certain degree, however, normally we have at least an inkling whether our own interests diverge from the salesperson's and we have a better contextualization to assess our choices. The game described is a game of incomplete information.

not round. The design was setup to explore the somewhat opposing topics of regret and curiosity and their relationship to additional information and feedback. The authors hypothesized that (a) additional knowledge increases curiosity, (b) without information participants would be more likely to avoid regret (i.e. with unconditional feedback they would be more likely to pick the sealed package than with conditional feedback), (c) with additional information participants would be more curious about the package and thus those with conditional feedback are expected to choose the package more than those with unconditional feedback. The three hypotheses were supported by their data. This experiment has a close relationship to the Suitcase Game as the participant chooses between a fixed value and an unknown alternative. However, many differences exist in the setup of the two games. Firstly, the SPP is played as a one-shot task whilst the suitcase game involves sixteen trials. Secondly, the SPP is not a strategic game: it is not played against a strategic agent (instead the experimenter decides upon the content of the package without any competitiveness between the experimenter and the participants) and it may not even be a constant-sum game (since the total earnings are earned by one player who (assumedly) earns a different pay-off depending on his choice). Finally, the manipulations in the SPP are such that curiosity is piqued by additional information whilst feelings of regret are induced by unconditional feedback. In the Suitcase Game we sometimes provide additional information but this is in the shape of two amounts that can be seen as minimum and maximum values for the original suitcase content; these values do not pique curiosity they simply provide knowledge to base decisions on. Furthermore, the Suitcase Game solely provides unconditional feedback and it remains questionable whether conditional feedback would still induce curiosity when the ‘sealed package’ is reduced to a monetary amount.

1.5 Outline of the thesis

We end this chapter by providing the reader with an outline of the thesis. The next three chapters discuss the experimental games in more detail. We start by introducing the Envelope Game (Chapter 2), then we continue with the Transfer Game (Chapter 3) and finally we discuss the Suitcase Game (Chapter 4). Next, we provide an overview of implications and future directions (Chapter 5). And finally we formulate an overall conclusion (Chapter 6). At the end of this thesis we include the reference list and appendix.

Chapter 2 Envelope Game: risk attitude and choices under imperfect information

Abstract

In this chapter we introduce a new sequential game involving imperfect information. We compute Nash predictions, predictions from level k models and predictions from the maximin principle. Our initial exploration compares experimental behaviour with theoretical predictions. Furthermore, the risk attitude of our sample is assessed after the experiment to allow the assessment of a potential relationship between experimental behaviour and risk attitude. Our findings suggest that behaviour cannot be explained by these frameworks on their own.

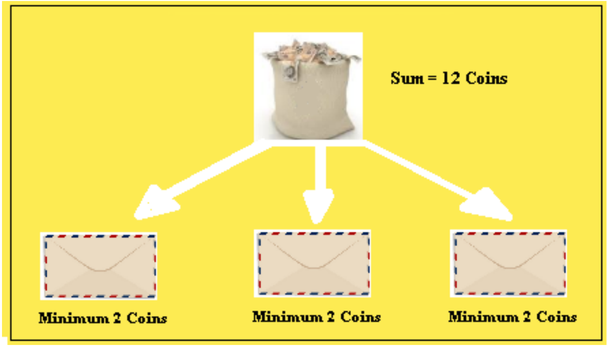
Introduction

There are many scenarios in real life where one person's gains result in another person's losses; and often these scenarios involve asymmetric information. Therefore, it is of considerable interest how people reason about such problems and how they should approach them. An easy example involves a car dealer who places a discount on one of his cars. Real life consumers are often drawn towards discounted items, however, a rational agent may worry whether the discount signals an underlying issue. In this paper we explore when and how value-changes are made in a context of imperfect information and how participants should approach these scenarios (i.e. do they reason things through from a complex game theoretic standpoint or do they explore simple reasoning strategies).

Paradigm

We propose a two-player game involving three envelopes that respectively contain X, Y and Z coins. Participants are informed that a minimum of two coins is present in each envelope and that the three envelopes sum to exactly twelve coins[6] (see Figure 11).

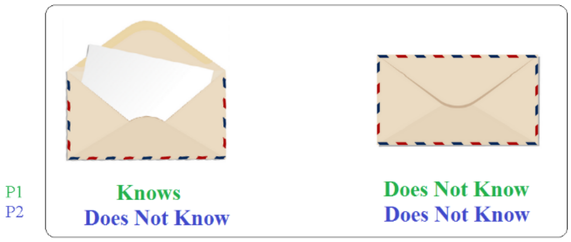
Figure 11: Coins in the Three Envelopes



This figure summarizes the background knowledge that is given to participants in the envelope game. There are three envelopes initially which each contain at minimum two coins and it is known that the sum of the three envelopes is exactly twelve coins.

One envelope is destroyed by Player One (P1) with neither player knowing its content. A second envelope is then opened by P1 and he can assess its content but Player Two (P2) cannot. The third envelope remains closed and neither player knows its content. Only the 'opened' and 'closed' envelopes are relevant to participants. The knowledge structure of the game is summarized in Figure 12.

Figure 12: Knowledge structure in the Envelope Game



The task for P1 is to decide how many coins (if any) to transfer from the opened envelope (OE) to the closed envelope (CE). Coins are integer values and thus the smallest unit that can be transferred is a single coin. The task for P2 is to choose between the OE and the CE. Since the unchosen envelope is given to P1 it is a purely competitive game. Of high importance is the fact that P2 knows how many coins are

[6] We provide this information (minimum two coins in each envelope and the sum of the envelopes is exactly twelve coins) to ensure that all participants perceive the task in a similar way. It would not be ideal if a transfer of three coins is considered small by one participant and huge by another participant.

transferred even though she does not know the initial content of any of the envelopes.

Finally, we explain to the reader why we included the destroyed envelope (DE) in our design – it indeed seems seem odd to include a third envelope simply to destroy it at the start of the game, however, there is an underlying logic. Our desire in this game is to explore how P1 behaves when he has limited knowledge and thus it is essential that the content of the CE cannot be deduced by subtracting the content of the OE from the total sum of twelve coins that are spread out across the envelopes (without the DE this would have been possible). Furthermore, we cannot omit the knowledge of the summed total of the envelopes since this would make it hard to control for within-subject differences in perception on the relative size of the OE-content.

Links to the literature

It is worthwhile to inform the reader that we include a risk attitude assessment at the end of our experimental sessions. We are curious how experimental behaviour from our novel game relates to risk attitudes. Dohmen et al. (2011) stated that risk measurements generally take place in context of a financial lottery but that alternative approaches can reach similar conclusions and be easier to understand. Furthermore, data from their follow-up survey (with different subjects) suggested that the best predictor for any given context originates from its own context. The literature generally suggests that participants behave risk aversely in experiments (e.g. Dohmen et al., 2011; Holt and Laury, 2002).

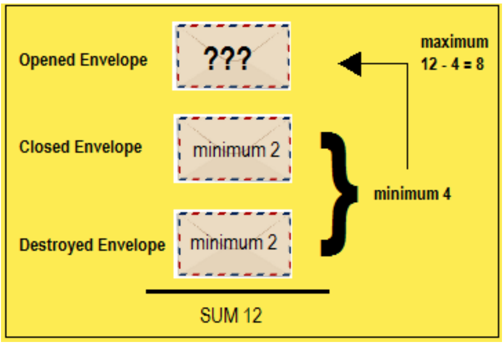
Assumptions and game structure

In this chapter we refer to P1 as ‘Opener’ whilst we refer to P2 as ‘Chooser’[7]. We now discuss the assumptions and game structure in more detail. In this thesis we make the assumption that participants want to maximize their own pay-off (and thus

[7] These terms are used interchangeably in this chapter, but we use a different terminology for P1 across experimental games (to make it easier for the reader to distinguish between the three games). In Chapter 3 we will refer to P1 as ‘Decider’ and in Chapter 4 we refer to P1 as ‘Splitter’.
The terminology for P2 is kept consistent (‘Chooser’ in each chapter) given that the task for P2 is consistent across our three games.

minimize the pay-off of the other player). Furthermore, since the Opener knows the content of the OE – which differs between trials – we assume that his behavioural differences are due to differential OE-values. Similarly, the Chooser knows the number of coins that is transferred from the OE to the CE and thus we assume that her behavioural differences are due to differences in the transfer amount. It can be computed that the OE contains at most eight coins since the CE and DE each require a minimum of two coins (i.e. 2+2=4) whilst the three envelopes must sum to exactly twelve coins (i.e. 12-4=8) (see Figure 13).

Figure 13: Maximum value of the OE



This figure illustrates that the maximum value of the OE must be eight coins. To assign the maximum number of coins to the OE it is required that both CE and DE have the minimum content (i.e. two coins each); Given that the three envelopes must sum to twelve coins it can thus be deduced that the OE contains maximum eight coins.

As a consequence rational Openers should never transfer more than three coins due to strong dominance: in the best scenario he finds eight coins in the OE whilst the CE only contains two coins; if three coins are transferred the two envelopes would contain five coins each (i.e. if more than three coins are transferred then the CE must contain more coins than the OE regardless their initial values). Whenever three coins (or more) are transferred the Chooser cannot be worse off from picking the CE – and thus the Opener cannot gain from transferring more than three coins. Since rational players would never transfer more than three coins we exclude these possibilities from our game theoretic analysis. The structure of the experimental game is illustrated in Table 3.

Table 3: The Expected Value of the CE in each scenario

Initial amount OE	Transfer 0		Transfer 1		Transfer 2		Transfer 3	
	OE	EV(CE)	OE	EV(CE)	OE	EV(CE)	OE	EV(CE)
2	2	5	1	6	0	7		
3	3	4.5	2	5.5	1	6.5	0	7.5
4	4	4	3	5	2	6	1	7

5	5	3.5	4	4.5	3	5.5	2	6.5
6	6	3	5	4	4	5	3	6
7	7	2.5	6	3.5	5	4.5	4	5.5
8	8	2	7	3	6	4	5	5

The Opener finds out how many coins are initially in the OE and decides how many coins to transfer. He thus knows how many coins are left in the OE if he transfers ‘x’ coins; furthermore, he can compute the expected value (EV) for the CE when a transfer of ‘x’ coins is made. His computations of $EV(CE)$ take into account how many coins are initially in the OE and respect the requirement that a minimum of two coins is found in each envelope (see Appendix 1.1 for details and an example on the computation of $EV(CE)$). The reader should note that each of the scenarios from Table 3 occurs with a different probability as is indicated in Table 4. The computation of these probabilities is described in Appendix 1.2.

Table 4: probability of finding 'x' coins in the OE

Initial amount OE	Probability
2	$\frac{64}{729}$
3	$\frac{192}{729}$
4	$\frac{240}{729}$
5	$\frac{160}{729}$
6	$\frac{60}{729}$
7	$\frac{12}{729}$
8	$\frac{1}{729}$

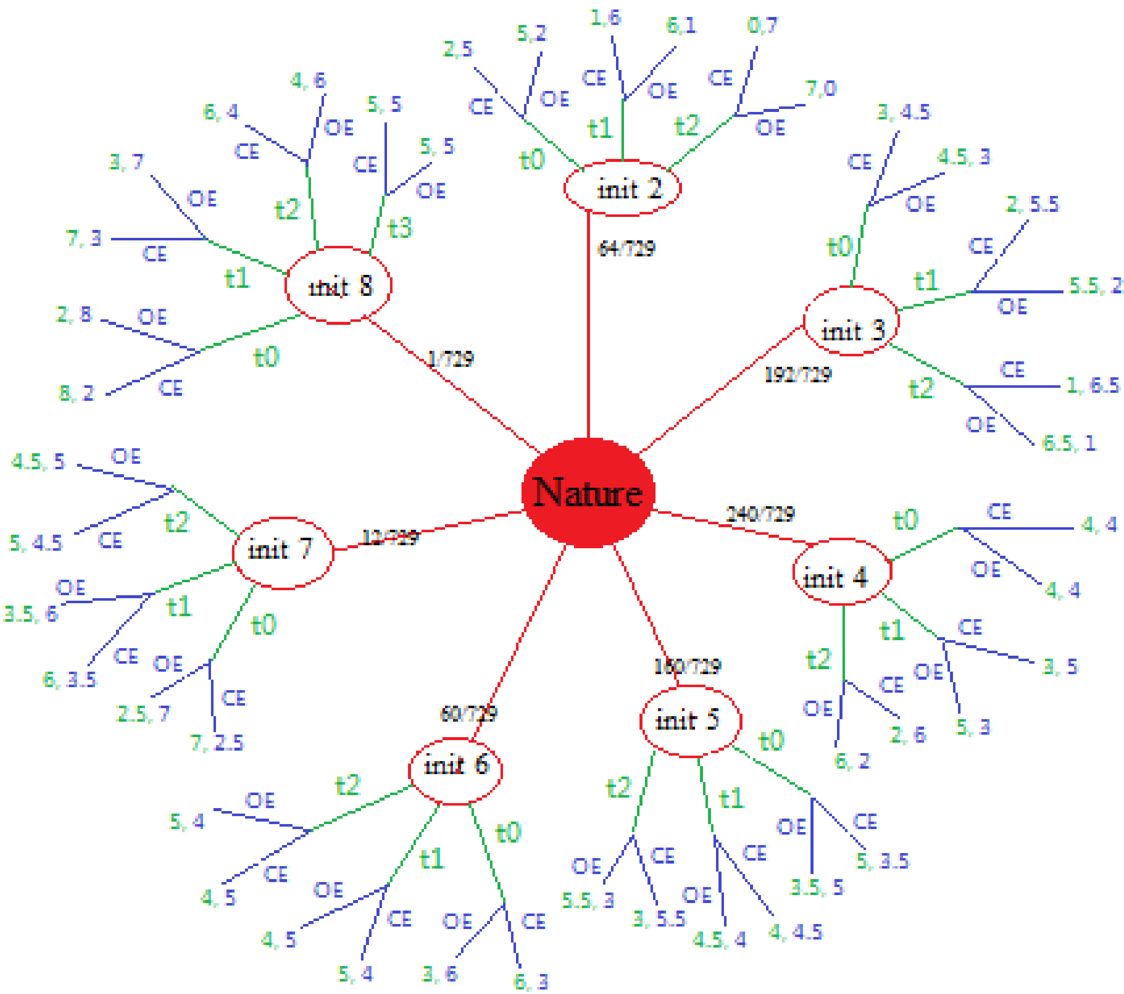
This table summarizes the probability in which the OE is expected to contain two, three, four, five, six, seven or eight coins.

Before we discuss the predictions for Nash, level k and maximin we point out to the reader that the computation of Nash predictions are often quite complex even in the context of the simple games that we discuss across our chapters. Furthermore, level k predictions oftentimes require additional assumptions to reach a stable state.

Nash predictions

In this section we discuss the Nash predictions for the Envelope Game. Since we discuss a sequential game involving imperfect information we explore the Perfect Bayesian Nash Equilibria (PBNE). The basic structure of the game is displayed in Figure 14; however, decisions that lead to dominant choice options for the opposing player are excluded from the game tree – as they can never be part of the Nash Equilibrium in a competitive game. Furthermore, we point out to the reader that P2 is aware about the actions taken by P1 but these “information sets” are omitted from the figure to avoid cluttering it unnecessarily. The figure is only meant to give a rough indication of the underlying complexity of the game and its structure.

Figure 14: Structure of the Envelope Game



Firstly, Nature (i.e. red colours) dictates how many coins are found in the OE – this knowledge is referred to as P1’s *type* and has values such as ‘init 2’ in our figure (e.g. “the initial value of the opened envelope is 2 coins”). It is worthwhile to explain that ‘type’ is a commonly used term in signalling games to refer to a feature assigned by nature to P1 which P2 cannot assess. In our setup P1’s type thus refers to the initial content of the OE. The probabilities of each type occurring by random chance are indicated on the branches (these probabilities have been computed in Appendix 1.2). P1 decides how many coins to transfer from the OE to the CE (i.e. green colours). Finally, P2 decides whether she wants the OE or the CE as her pay-off (i.e. blue colours). The end-nodes of each decision-branch display the pay-offs of the two players. The pay-off nodes consist of the value in the OE (which is a fixed value for each branch) and the expected value of the CE (which is not a fixed value). Table 5 reminds the reader how expected values are computed for each branch of the decision tree (the computation of this table is explained in Appendix 1.1).

Table 5: EV(CE) values in each scenario

Amount OE	Transfer 0		Transfer 1		Transfer 2		Transfer 3	
	OE	EV(CE)	OE	EV(CE)	OE	EV(CE)	OE	EV(CE)
2	2	5	1	6	0	7		
3	3	4.5	2	5.5	1	6.5	0	7.5
4	4	4	3	5	2	6	1	7
5	5	3.5	4	4.5	3	5.5	2	6.5
6	6	3	5	4	4	5	3	6
7	7	2.5	6	3.5	5	4.5	4	5.5
8	8	2	7	3	6	4	5	5

Before we discuss the PBNE computations in more detail we inform the reader about the different shapes in which a PBNE may exist. In order of discussion we will introduce potential Pooling, Separating, Semi-Separating and Fully Mixed PBNE’s.

Pooling PBNE

When P1 makes the same choice regardless his type (i.e. he transfer the same amount of coins) we speak of “Pooling PBNEs”. Potential Pooling PBNE’s are thus the following strategies: “always transfer 0 coins”, “always transfer 1 coin” or “always transfer 2 coins”. Larger transfer amounts (i.e. ≥ 3 coins) cannot result into Nash equilibria since P2 would have a ‘dominant choice’ ensuring that P2 receives a better or equal pay-off compared with P1 – this would make P1 deviate. Furthermore, there cannot be a Pooling PBNE in which P1 consistently transfers one coin; or two coins. The reason is that the two envelopes would have a different EV implying that P2 should consistently pick the CE – again, this would imply that P1 wants to change his choice at least for some of his ‘types’ (see Equation 1 and Equation 2).

Equation 1: Computing the EV for the two envelopes if one coin is transferred by each type of P1

$$\text{EV(OE)}= \frac{64}{729}\times 1+\frac{192}{729}\times 2+\frac{240}{729}\times 3+\frac{160}{729}\times 4+\frac{60}{729}\times 5+\frac{12}{729}\times 6+\frac{1}{729}\times 7$$

$$=\frac{2187}{729}=3$$

$$\text{EV(CE)}= \frac{64}{729}\times 6+\frac{192}{729}\times 5.5+\frac{240}{729}\times 5+\frac{160}{729}\times 4.5+\frac{60}{729}\times 4+\frac{12}{729}\times 3.5+\frac{1}{729}\times 3$$

$$=\frac{3645}{729}=5$$

Equation 2: Computing the EV for the two envelopes if two coins are transferred by each type of P1

$$\text{EV(OE)}= \frac{64}{729}\times 0+\frac{192}{729}\times 1+\frac{240}{729}\times 2+\frac{160}{729}\times 3+\frac{60}{729}\times 4+\frac{12}{729}\times 5+\frac{1}{729}\times 6$$

$$=\frac{1458}{729}=2$$

$$\text{EV(CE)}= \frac{64}{729}\times 7+\frac{192}{729}\times 6.5+\frac{240}{729}\times 6+\frac{160}{729}\times 5.5+\frac{60}{729}\times 5+\frac{12}{729}\times 4.5+\frac{1}{729}\times 4$$

$$=\frac{4374}{729}=6$$

The only possible Pooling PBNE requires P1 to consistently “transfer zero coins”. Equation 3 illustrates that the expected payoff for P2 is unaffected by her decision whenever P1 decided to not make a transfer.

Equation 3: Computing the EV for the two envelopes if zero coins are transferred by each type of P1

$$\text{EV(OE)}= \frac{64}{729}\times 2+\frac{192}{729}\times 3+\frac{240}{729}\times 4+\frac{160}{729}\times 5+\frac{60}{729}\times 6+\frac{12}{729}\times 7+\frac{1}{729}\times 8$$

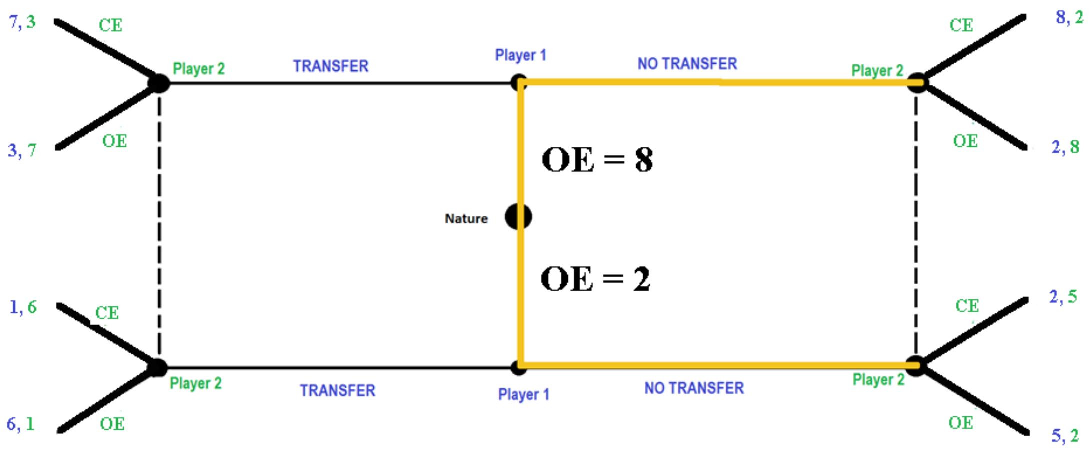
$$=\frac{2916}{729}=4$$

$$\text{EV(CE)}= \frac{64}{729}\times 5+\frac{192}{729}\times 4.5+\frac{240}{729}\times 4+\frac{160}{729}\times 3.5+\frac{60}{729}\times 3+\frac{12}{729}\times 2.5+\frac{1}{729}\times 2$$

$$=\frac{2916}{729}=4$$

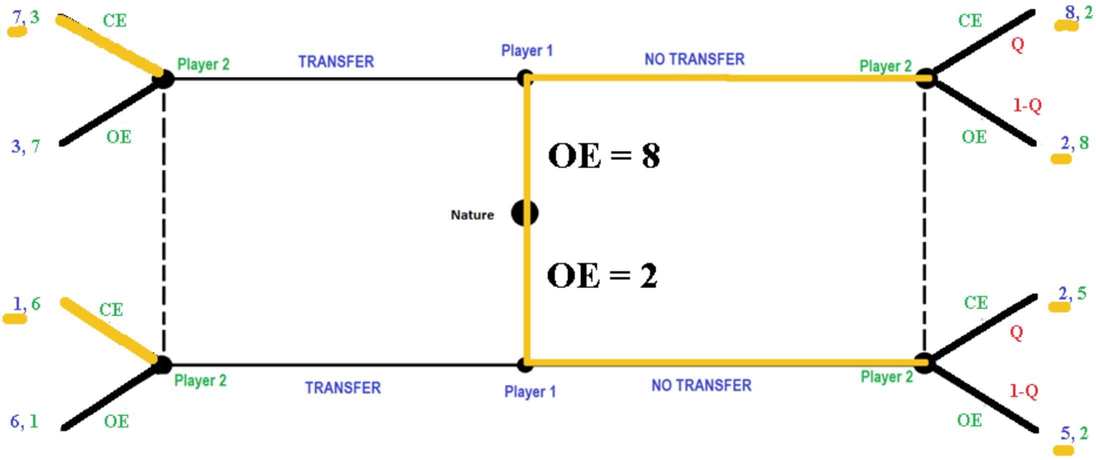
Given that EV(CE|no transfer)= EV(OE|no transfer) P2 can choose the CE in any probability she likes when no transfer is made – though later on we will set restrictions on this probability such that we can ensure the existence of the equilibrium state (if possible). To simplify the next step in exploring the potential Pooling PBNE we reduce the number of types to the most extreme cases (i.e. OE=8 and OE=2) since all other cases would hold if both OE=8 and OE=2 are able to maintain an equilibrium state together. The simplified game structure and its potential Pooling PBNE state is displayed in Figure 15.

Figure 15: Simplified structure to contrast the most extreme scenarios



The potential Pooling PBNE is indicated by orange colour on the game tree. P1's decisions and payoffs are indicated in blue and P2's decisions and payoffs are indicated in green. Our general approach to explore whether a PBNE exists is to first assume that it exists and to assess which parameters are required for it to be a stable state; if we cannot set parameters without contradiction then we can conclude that the assumed PBNE state doesn't exist. The first parameter to compute, Q, expresses the minimal probability at which P2 should select the CE when no transfer is made *such that P1 does not desire to deviate regardless his type*. To compute these parameter values we do not need to take the probability of each type in account since we make comparisons between the expected payoffs (EP) of transferring versus not transferring within the same type. These probabilities are only relevant when we compute the expected payoff for P2 (EP_{P2}); here, we simply compute how P2 should behave when no transfer is made *such that P1 has no desire to ever make the transfer*. Concretely, we compute the expected payoff for P1 (EP_{P1}) from transferring if P2 were to consistently pick the CE if a transfer is made; and compare with his EP from not transferring if P2 picked the CE with probability Q if no transfer is made[8]. This allows us to set the value of Q such that P1 cannot gain from transferring which is a requirement to be in the assumed equilibrium state (see Figure 16 and Equation 4).

Figure 16: Setting the value for Q



Equation 4: Setting the value for Q

$$\mathrm{EP}_{\mathrm{P1}}\left(\text{transfer0}|\text{OE=8}\right) \geq \mathrm{EP}_{\mathrm{P1}}\left(\text{transfer1}|\text{OE=8}\right)$$

$$8Q+2(1-Q) \geq 7 \Leftrightarrow 8Q+2-2Q \geq 7 \Leftrightarrow 6Q \geq 5 \Leftrightarrow Q \geq \frac{5}{6}$$

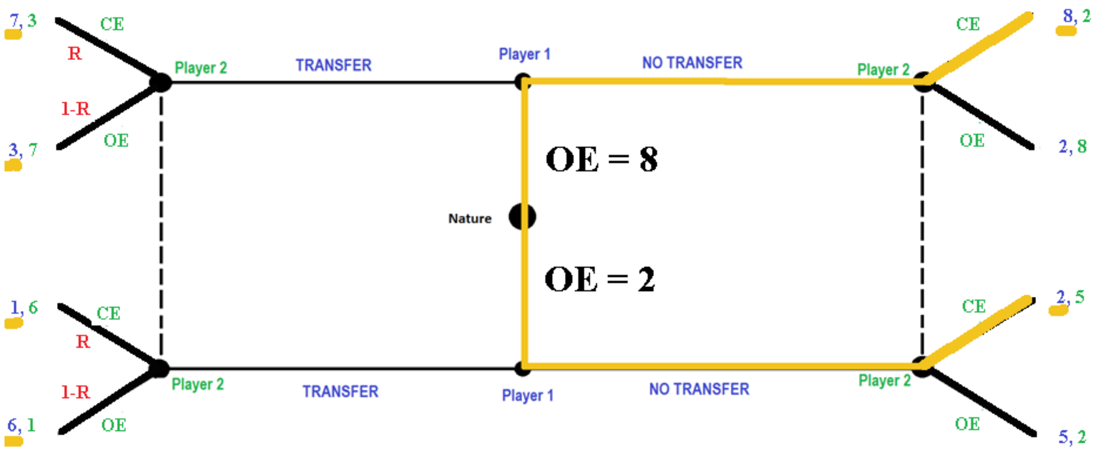
$$\mathrm{EP}_{\mathrm{P1}}\left(\text{transfer0}|\text{OE=2}\right) \geq \mathrm{EP}_{\mathrm{P1}}\left(\text{transfer1}|\text{OE=2}\right)$$

$$2Q+5(1-Q) \geq 1 \Leftrightarrow 2Q+5-5Q \geq 1 \Leftrightarrow -3Q \geq -4 \Leftrightarrow Q \leq \frac{4}{3}$$

Next, we relax P2's preference of picking the CE when a transfer is made: we compute the minimum probability in which P2 should select the CE if a transfer is made such that P1 does not desire to deviate. We again make the comparison with a consistent CE-decision as this is the most extreme case possible for which our parameter R must hold true (see Figure 17 and Equation 5).

Figure 17: Setting the value of R

[8] We point out to the reader that we compare $\mathrm{EP}_{\mathrm{P1}}$ from not transferring with a consistent CE-preference if a transfer were made simply because it is the most extreme scenario for which our Q-value needs to hold true. I.e. the equilibrium should exist if P2 were to pick CE consistently if a transfer is made; meanwhile the equilibrium will not hold if the OE were picked consistently if the transfer is made. Thus, a 100% preference for the CE when the transfer is made offers the most extreme case that has to be satisfied for an equilibrium state. When we later compute the parameter R we calculate which alternative probabilities of CE-preference when transfers are made maintain the equilibrium state.



Equation 5: Setting the value of R

$$\mathrm{EP_{P1}}\left(\mathrm{transfer0|OE{=}8}\right) \geq \mathrm{EP_{P1}}\left(\mathrm{transfer1|OE{=}8}\right)$$

$$7R+3(1-R)\leq 8 \Leftrightarrow 7R+3-3R\leq 8 \Leftrightarrow 4R\leq 5 \Leftrightarrow R\leq \frac{5}{4}$$

$$\mathrm{EP_{P1}}\left(\mathrm{transfer0|OE{=}2}\right) \geq \mathrm{EP_{P1}}\left(\mathrm{transfer1|OE{=}2}\right)$$

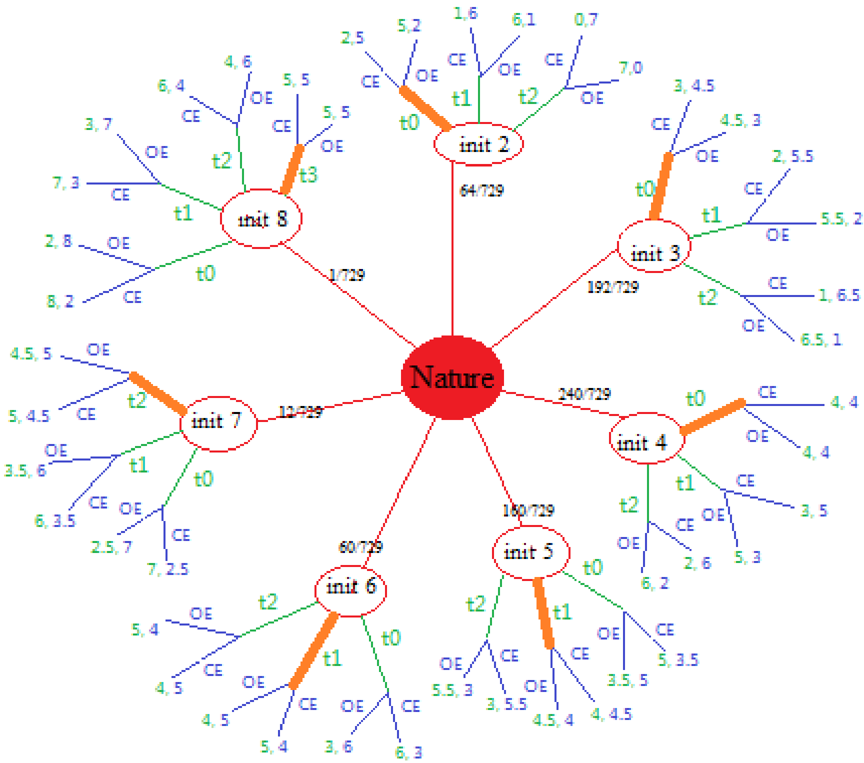
$$1R+6(1-R)\leq 2 \Leftrightarrow 1R+6-6R\leq 2 \Leftrightarrow -5R\leq -4 \Leftrightarrow R\geq \frac{4}{5}$$

We conclude that a Nash equilibrium in which P1 never transfers coins is found as long as P2 picks the CE at least 83% of the time when no transfer is made (i.e. $Q \geq \frac{5}{6}$) whilst picking the CE at least 80% of the time if a transfer were somehow made ($R \geq \frac{4}{5}$). Together these choice probabilities ensure that P1 cannot gain from transferring a single coin even in the most extreme scenarios (i.e. even in OE=8 and OE=2); thus, P1 would not desire to deviate from the equilibrium state. We point out to the reader that the same choice probabilities ensure that larger transfers are not preferred either (i.e. if P1 does not desire to make a one-coin transfer in these conditions then he surely does not want to make a two-coin transfer either).

Separating PBNE

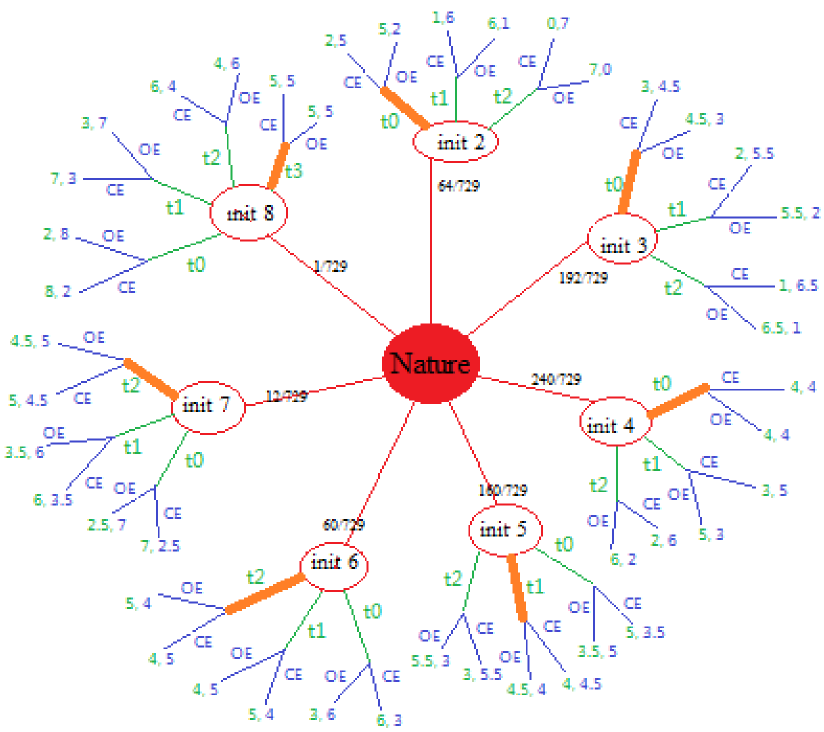
The next PBNE we explore is the Separating PBNE. Here different types employ different strategies. There are two Separating PBNE's possible. They both involve zero coin transfers for types init2, init3 and init4 – if this were not the case then these types would want to deviate to a zero coin transfer. Furthermore, type init5 makes a one coin transfer, type init7 makes a two coin transfer and type init8 makes a three coin transfer – again, else they would want to deviate to these strategies. The first Separating PBNE we explore has type init6 transferring one coin (Figure 18); and the second Separating PBNE has type init6 transferring two coins (Figure 19). Note that P1 may also use a mixed strategy for type init6 but this would be classified as Semi-Separating PBNE and is discussed in the next section.

Figure 18: Exploring a Separating PBNE where type init6 transfers one coin



If type init6 transfers one coin then P2 would pick the CE for zero coin transfers whilst she would pick the OE for one and two coin transfers (due to a higher EV). P1s of type init2, init3 and init4 would want to change their choice and transfer one or two coins whilst type init5, init6 and init7 would want to change and transfer 0 coins. This is not a PBNE.

Figure 19: Exploring a Separating PBNE where type init6 transfers two coins

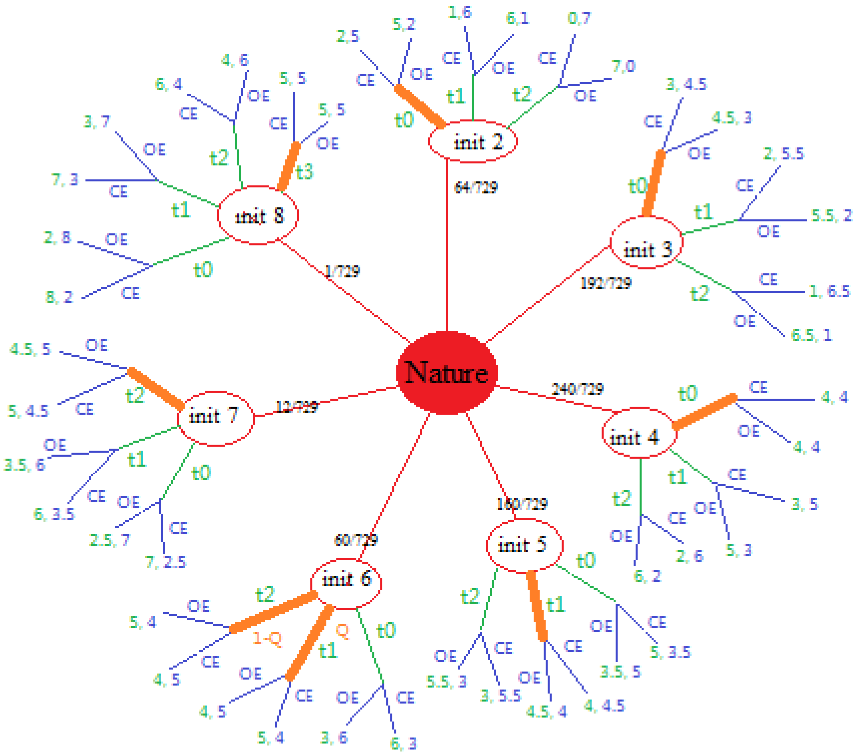


If Type init6 transferred two coins then P2 would pick the CE for zero, one and two coin transfers (due to higher EVs). P1 would want to change strategies as he is better off by not increasing the CE-value. There is again no PBNE.

Semi-Separating PBNE

The next PBNE we explore is the Semi-Separating PBNE; an equilibrium is possible in which type init6 mixes between transferring one and two coins. The other types would have pure strategies – type init2, init3 and init4 would transfer zero coins; type init5 would transfer one coin; type init7 transfers two coins and type init8 transfers three coins (see Figure 20).

Figure 20: Exploring a potential Semi-Separating PBNE



The first step to explore whether there is such a PBNE is to compute the probability of being in the 'init6' node if a transfer of one coin is made; and to compute the probability of being in the 'init6' node if a transfer of two coins is made. These probabilities should not contradict each other for a PBNE to exist. Bayes' rule is used for these computation; and as can be seen in Figure 20 we coded the probability of 'transferring one coin' when in the init6 node as 'Q' whilst the probability of 'transferring two coins' when in the init6 node is coded as '1-Q'.

<u>If transfer 1:</u>

$$prob_{init6|t1} = \frac{prob_{init6} * prob_{t1|init6}}{prob_{init6} * prob_{t1|init6} + prob_{init5} * prob_{t1|init5}}$$

$$= \ prob_{init6|t1} = \frac{\frac{60}{729} * Q}{\frac{60}{729} * Q + \frac{160}{729} * 1}$$

(<u>Note</u>: we temporarily equate this function to the variable 'X' for ease of calculations)

Next, we compute the expected pay-off for P2 if a one-coin transfer is made, based on the probabilities we computed. Our goal is to make P2 indifferent between picking the OE and the CE (i.e. a requirement for the PBNE to exist) so we equate the EP of the two envelopes which allows us to compute the probability of being in the 'init6' node when a one-coin transfer is made.

<u>Expected Payoff for P2 if one coin is transferred:</u>

- EV(OE)= 5(X) + 4(1-X)
- EV(CE)= 4(X) + 4.5(1-X)
- To be indifferent between OE and CE it is required that:

5(X) + 4(1-X) = 4(X) + 4.5(1-X) $\Leftrightarrow$ X + 4 - 4X = 4.5 - 4.5X $\Leftrightarrow$

5.5X - 4X = 4.5 - 4 $\Leftrightarrow$ 1.5X = 1.5 $\Leftrightarrow$ X = 1

Given that we coded $prob_{init6|t1}$ as 'X' this means:

$$\Leftrightarrow prob_{init6|t1} = \frac{\frac{60}{729} * Q}{\frac{60}{729} * Q + \frac{160}{729} * 1} = 1$$

From this we compute the required probability of transferring one coin if you are of type init6 (i.e. the variable Q). As this computation results into an erroneous result (see Equation 6), we know that there is no PBNE possible that fits the requirements – and hence we do not even need to look at the EP if two coins were to be transferred.

Equation 6: Solving the equation for the value of Q

$$prob_{init6|t1} = \frac{\frac{60}{729} * Q}{\frac{60}{729} * Q + \frac{160}{729} * 1} \mathbf{= X = 1}$$

$$\Leftrightarrow \frac{\frac{60}{729} * Q}{\frac{60}{729} * Q + \frac{160}{729} * 1} = 1 \Leftrightarrow \frac{60}{729} * Q = \frac{60}{729} * Q + \frac{160}{729} * 1 \Leftrightarrow 0 = 0 + \frac{160}{729} * 1 \Leftrightarrow 0 = \frac{160}{729}$$

There is no Semi-Separating PBNE.

Fully Mixed PBNE

Finally, it is possible for a Fully Mixed PBNE to exist. This would mean that both P1 and P2 use mixed strategies. However, in such a scenario P2 would simply deviate towards picking the CE consistently as it provides a higher EV. Hence, there can be no Fully Mixed PBNE.

Note to the reader:

Notice that there is no PBNE in which P1 transfers zero coins in all scenarios except for the scenario where he finds 8 coins (in which he can equalize the envelopes by making a three-coin transfer). This is because it would affect the $\mathrm{EV}(\mathrm{OE})$ and $\mathrm{EV}(\mathrm{CE})$ such that $\mathrm{EV}(\mathrm{CE})>\mathrm{EV}(\mathrm{OE})$ whenever a zero-coin transfer is made. P2 would have a better deal unless P1 changes his strategy such that he transfers zero coins also when he finds 8 coins in the OE.

Risk Averse Behaviour

Finally, we explore how risk averse participants would behave according to the Nash equilibrium. Our predictions are that the risk averse Opener does not desire to deviate from his risk neutral equilibrium strategy: if he were to transfer his EP would decrease. Thus, the Opener continues to use his never transfer strategy. For a risk averse Chooser we expect the equilibrium state to involve a consistent CE-decision if a transfer were (hypothetically) made since this provides her with a higher EV; furthermore, if no transfer is made we expect her to pick the CE consistently too given that $\mathrm{EV(CE)}$ can never be worse than $\mathrm{EV(OE)}$.

Nash Conclusion

The Nash equilibria for this game involve Openers to consistently not transfer coins (i.e. resulting into equal EVs for the two envelopes). The most obvious equilibrium state that can be reached is a state in which the Chooser consistently picks the CE – this strategy implies that the Opener does not desire to transfer since any transfer he makes simply decreases the OE-value that he himself expects to receive as payoff. Furthermore, the Chooser does not desire to deviate from her strategy since the two envelopes have the same EV: she cannot gain from selecting the OE. However, this equilibrium state can be maintained even if the Chooser uses a mixed strategy. Concretely, she should pick the CE when no transfer is made at least 83% of the time to ensure that P1 cannot gain from transferring if he were to find a large amount in the OE; furthermore, she should pick the CE in at least 80% of the cases if a (hypothetical) [9] transfer is made to ensure that the Opener cannot gain from transferring if he were to find the lowest value in the OE. These percentages are computed such that even the most extreme OE-values cannot compel the Opener to make a one-coin transfer; and obviously, he cannot gain from larger transfers either as long as the Chooser uses this strategy.

The only possible risk averse PBNE is for P1 to never transfer and for P2 to consistently pick the CE.

Level k predictions

In this section we discuss level k predictions for the Envelope Game. We use a simplified notation to denote the level of reasoning for the Opener as O_x whilst we denote the level of reasoning for the Chooser as C_x; the subscript ‘x’ refers to their level of reasoning. For example, O_0 refers to the Opener reasoning at level 0. Experimental evidence suggests that participants are mostly reasoning at level one and level two (Colman, Pulman and Lawrence, 2014; Camerer, Ho and Chong, 2004), however, we allow ourselves to assess predictions a few steps further such that we can compare experimental behaviour with a larger number of possible strategies. We make the assumptions that each player considers themselves to reason exactly one level higher than their opponent and that they aim to make a best response on the assumed behaviour of the opponent. Thus, O_x makes his decisions on assumption that his opponent is C_{x-1} whilst C_x makes her decisions on

[9] We speak of a ‘hypothetical’ transfer since our equilibrium state suggests that transfers are never made; However, to ensure that this state is ‘stable’ Choosers have to pick the CE with a certain probability if a transfer were made such that the Opener expects to lose out from transferring. This scenario is hypothetical in the sense that the equilibrium suggests that such a scenario would not occur but it is a required parameter for the equilibrium to exist.

assumption that her opponent is O_{x-1}. The starting point for analysis is O_0 and C_0. We first discuss level k predictions under assumption of risk neutrality since this is the way level k models were initially designed; afterwards, we also explore level k predictions under the assumption of risk averseness since experimental research often suggests that participants behave in a risk averse way (e.g. Dohmen et al., 2011). To our knowledge we are the first study to explore level k predictions under the assumption of risk averseness. Summary tables of decisions made at each level of reasoning are provided both for the risk neutrality (Table 6) and risk aversion (Table 8).

We start with risk neutral predictions. O_0 and C_0 are unsophisticated players who make random decisions without considering the actions of their opponent. At level one we start observing strategic behaviour since O_1 makes a best response to C_0 whilst C_1 makes a best response to O_0. Since he expects his opponent to choose randomly O_1 does not need to change his best-response strategy: he randomly decides how many coins to transfer. Meanwhile, C_1 expects random behaviour from her unsophisticated O_0-opponent and she realises that this implies a higher EV for the CE whenever a transfer is made. If no transfer is made she knows that it is not due to a strategic consideration which implies that she can decide randomly (i.e. $\mathrm{EV(CE)=EV(OE)}$). We now reach level two reasoning. O_2 tries to exploit C_1's decision rule by transferring exactly one coin when the OE contains a large enough value to ensure that $\mathrm{OE - 1coin > EV(CE) + 1coin}$ whilst not transferring in other scenarios. Concretely, he transfers one coin when the OE contained six, seven or eight coins whilst he does not transfer coins when the OE contained two, three or four coins. O_2 is indifferent between transferring one coin versus not transferring when five coins are found in the CE. Meanwhile, C_2 behaves the same as C_1: she chooses the CE when a transfer is made (due to its higher EV) whilst she chooses randomly when no transfer is made. We now reach level three reasoning. O_3 behaves the same as O_2: he transfers one coin when the OE contained six, seven or eight coins whilst he does not transfer when the OE contained two, three or four coins. He randomly decides whether to transfer one coin or not whenever the OE contains five coins. Meanwhile, C_3 comes to the realisation that O_2 only transfers a coin when it results into a higher EV for the OE than for the CE whilst he does not transfer when the OE has four or less coins initially[10]; thus C_3 picks the OE whenever a coin is transferred whilst she picks the CE when no transfer is made. When we reach level four (or higher levels) it becomes clear that the Opener and Chooser keep reversing their strategies in attempt to outsmart their opponent. Thus, O_4 transfers one coin when the OE contains two, three or four coins whilst he does not transfer when the OE contains five, six, seven or eight coins. (Note that O_4 does not transfer when five coins are found: he expects to receive more coins by not transferring). Meanwhile, C_4 behaves the same as C_3 but reverses her strategy at level five, etc. A summary of the strategies used by risk neutral players is provided in Table 6.

Table 6: Level k reasoning for risk neutral choices

	Opener	Chooser
Level 0	Random	Random
Level 1	Random	if transfer is made: CE if no transfer is made: random
Level 2	if OE=6,7,8: transfer one coin if OE=5: transfer one or zero coins if OE=2,3,4: transfer zero coins	if transfer is made: CE if no transfer is made: random
Level 3	if OE=6,7,8: transfer one coin if OE=5: transfer one or zero coins if OE=2,3,4: transfer zero coins	if transfer one: OE if transfer zero: CE (other transfer amounts are not possible anymore)
Level 4	if OE=2,3,4: transfer one coin if OE=5,6,7,8: transfer zero coins	if transfer one: OE if transfer zero: CE
Level 5	if OE=2,3,4: transfer one coin if OE=5,6,7,8: transfer zero coins	if transfer one: CE if transfer zero: OE
Loop	Both players try to outsmart each other by reversing their strategy whenever the opponent exploits it on the previous level.	

Next, we discuss the level k predictions under assumption that the Opener is risk averse[11]. This analysis is original to the best of our knowledge and seems worthwhile to explore given that experimental literature typically concludes that participants are risk averse (and since we assess the risk attitude of our experimental sample). The main difference for our risk averse predictions is that O_0 attempts to

[10] Of course, if the OE contains five coins he randomly decides whether to transfer one coin or not.

[11] We explore risk aversion solely through the Opener given that level k reasoning is a *sequential* exploration of reasoning processes and hence non-random behaviour for the level zero Chooser would lead to odd best-response sequences. Concretely, the Opener would change his strategy at level one based on his opponent's behaviour at level zero; meanwhile, the Chooser at level one would also change her strategy based on her opponent's level-zero behaviour. Allowing a non-random level-zero Chooser would break the 'sequential' reasoning processes that we aim to explore.

decrease the value difference between the two envelopes. Thus, O_0 transfers three coins if OE=8; transfers two coins if OE=7; transfer one or two coins if OE=6 (since the two strategies result into the exact same EV-difference between the two envelopes he is indifferent); and transfers one coin if OE=5. If two, three or four coins are found in the OE he cannot decrease the value difference and thus does not make a transfer. Meanwhile, C_0 is assumed to pick randomly. We now discuss level one. O_1 considers his opponent to behave randomly and thus he can behave in the same way as he did as O_0. However, C_1 now makes a best response on O_0 which implies that she expects to be in an OE=8 scenario when three coins are transferred in an OE=7 or OE=6 scenario when two coins are transferred, in an OE=6 or OE=5 scenario if one coin is transferred and in a OE=4, OE=3 or OE=2 scenario if no coins are transferred. To assess her best response strategy we look at Table 7.

Table 7: EV(CE) when zero, one or two coins are transferred

Probability	Initial OE	Transfer 0		Transfer 1		Transfer 2		Transfer 3	
		OE	EV(CE)	OE	EV(CE)	OE	EV(CE)	OE	EV(CE)
64/729	2	**2**	**5**	1	6	0	7		
192/729	3	**3**	**4.5**	2	5.5	1	6.5	0	7.5
240/729	4	**4**	**4**	3	5	2	6	1	7
160/729	5	5	3.5	**4**	**4.5**	3	5.5	2	6.5
60/729	6	6	3	**5**	**4**	**4**	**5**	3	6
12/729	7	7	2.5	6	3.5	**5**	**4.5**	4	5.5
1/729	8	8	2	7	3	6	4	**5**	**5**

When no coins are transferred C_1 observed that EV(CE)>EV(OE) and thus she picks CE. When one or two coins are transferred CE remains a better option (see Equation 7 and Equation 8).

Equation 7: EV(CE) and EV(OE) when one coin is transferred based on assumptions

$$\mathrm{EV(CE)}=4\times \mathrm{prob}_{\mathrm{initialOE=6}}+4.5\times \mathrm{prob}_{\mathrm{initialOE=5}}$$

$$\mathrm{EV(OE)}=5\times \mathrm{prob}_{\mathrm{initialOE=6}}+4\times \mathrm{prob}_{\mathrm{initialOE=5}}$$

$$\mathrm{EV(CE)}>\mathrm{EV(OE)} \Leftrightarrow 4\times \mathrm{prob}_{\mathrm{initialOE=6}}+4.5\times \mathrm{prob}_{\mathrm{initialOE=5}} > 5\times \mathrm{prob}_{\mathrm{initialOE=6}}+4\times \mathrm{prob}_{\mathrm{initialOE=5}}$$
$$\Leftrightarrow 0.5\times \mathrm{prob}_{\mathrm{initialOE=5}} > 1\times \mathrm{prob}_{\mathrm{initialOE=6}} \Leftrightarrow 0.5\times 160 > 1\times 60 \Leftrightarrow 80 > 60$$

(Note that this inequality holds regardless the probability in which OE=6 ends up transferring one instead of two coins).

Equation 8: EV(CE) and EV(OE) when two coins are transferred based on assumptions

$$\mathrm{EV(CE)}=4.5\times \mathrm{prob}_{\mathrm{initialOE=7}}+5\times \mathrm{prob}_{\mathrm{initialOE=6}}$$

$$\text{EV(OE)}=5\times \text{prob}_{\text{initialOE=7}}+4\times \text{prob}_{\text{initialOE=6}}$$

$$\text{EV(CE)>EV(OE)} \Leftrightarrow 4.5\times \text{prob}_{\text{initialOE=7}}+5\times \text{prob}_{\text{initialOE=6}}>5\times \text{prob}_{\text{initialOE=7}}+4\times \text{prob}_{\text{initialOE=6}}$$
$$\Leftrightarrow 1\times \text{prob}_{\text{initialOE=6}}>0.5\times \text{prob}_{\text{initialOE=7}} \Leftrightarrow 1\times 60>0.5\times 12 \Leftrightarrow 60>6$$

(Note that this inequality holds as long as the probability in which a two coin transfer is made when OE=6 is 10% or more of the OE=6 cases[12]).

Finally, when three coins are transferred C_1 expects both envelopes to be equal which means that she can pick randomly; this allows the possibility of consistently choosing the CE which is arguably the most sensible choice given that CE cannot be worse than OE when three coins are transferred (due to strong dominance). Thus, C_1 uses a strategy of consistently picking CE. We now discuss level two. O_2 realises that C_1 consistently chooses the CE and thus his best response is to never transfer coins. C_2 behaves the same as C_1: she consistently picks the CE. We now discuss level three. O_3 behaves the same as O_2: he never transfers coins because the opponent consistently picks the CE regardless his own decision. Meanwhile, C_3 is aware that O_2 never makes the transfer. She cannot make a better 'best response' than her strategy from the previous level and a stable state is reached[13]. The Opener never transfers whilst the Chooser consistently picks the CE. A summary of the strategies used by risk averse players is found in Table 8.

Table 8: Level k reasoning when the Opener is risk averse

	P1	P2
Level 0	If OE=8: transfer 3 If OE=7: transfer 2 If OE=6: transfer 2 or 1 If OE=5: transfer 1 If OE=4, 3 or 2: transfer 0	Random
Level 1	If OE=8: transfer 3 If OE=7: transfer 2 If OE=6: transfer 2 or 1 If OE=5: transfer 1 If OE=4, 3 or 2: transfer 0	If transfer 3: pick random/CE If transfer 2: pick CE If transfer 1: pick CE If transfer 0: pick CE
Level 2	Never transfer	CE
Level 3	Never transfer	CE

[12] Given that we assume it to be a random decision whether to transfer two coins versus one coin (whenever six coins are found in the OE by the risk averse Decider at level zero) it seems realistic to conclude that EV(CE) > EV(OE) when a two coin transfer is made.
[13] The reader may argue that her best response is to randomly choose if no transfer is made. However, this strategy is not better than the strategy she used at her previous level and we argue that there is no incentive for her to change.

Maximin principle

The maximin principle is a strongly pessimistic principle suggested by Wald in 1945 and ensures that the player receives the best out of all worst-case-scenario outcomes. Concretely, the participant assesses the worst possible outcome for each decision he can make; and he makes that decision whose worst outcome is superior to the worst outcome of the alternative decisions (Colman, 1982). Using the same table we introduced in the section on assumptions and game structure we indicate the maximin strategies with a green background in Table 9.

Table 9: Maximin strategies for P1

Initial amount OE	Transfer 0		Transfer 1		Transfer 2		Transfer 3	
	OE	EV(CE)	OE	EV(CE)	OE	EV(CE)	OE	EV(CE)
2	2	5	1	6	0	7		
3	3	4.5	2	5.5	1	6.5	0	7.5
4	4	4	3	5	2	6	1	7
5	5	3.5	4	4.5	3	5.5	2	6.5
6	6	3	5	4	4	5	3	6
7	7	2.5	6	3.5	5	4.5	4	5.5
8	8	2	7	3	6	4	5	5

This table illustrates the maximin predictions for the envelope game conditional on the amount that is initially found in the OE.

When the initial amount in the OE is two, three or four coins the maximin strategy for the Opener is to transfer zero coins since any transfer would increment the difference between the OE and EV(CE). For an initial amount of five coins in the OE his maximin strategy is to transfer one coin ensuring a minimum EP of four coins compared to a minimum EP of three and a half coins (if zero coins were transferred) or three coins (if two coins were transferred). When the initial amount in the OE is six coins there are two viable strategies according the theorem since both a one coin transfer and a two coin transfer result into the same minimum EP. His maximin strategy when seven coins are found in the OE is to transfer two coins since the minimum EP is then four and a half coins whilst it would be four coins (if three coins were transferred) or three and a half coins (if one coin were transferred). Finally, when the OE initially contains eight coins his maximin strategy is to transfer three coins since it results in a minimum payoff of five coins compared to a minimum EP of four or less coins.

For the Chooser the maximin strategy whenever a transfer is made is simply to pick the CE. She does not know the initial value of either envelope; however, she knows that both envelopes have the same minimum content of two coins initially. Thus, if a transfer is made the CE has a higher minimum value (i.e. two coins plus the transfer amount) compared with the OE (which remains with a minimum value of two coins minus the transfer amount[14]).

Experimental setup

Participants

Participants in our experiment were 36 students and employees from Warwick University, with an average age of 22 years old. Our sample was predominantly female (27 female, 13 male)[15]. Recruitment was done through SONA, an online system for participant recruitment. We decided in advance on a sample size of 36 participants with twelve participants in each of three experimental sessions. We opted for a relatively small sample in each of our experiments such that we can explore a 'proof of concept'; to help fine-tune future versions of these experiments and to assess whether our novel games are interesting to explore further before we make strong financial investments. Each session consisted of exactly twelve participants such that perception on the number of potential opponents remains constant and to make the experimental matchmaking slightly easier to program. To avoid cancelling sessions due to participants not showing up we recruited four additional participants per session; if more than twelve participants showed up before the starting time we randomly selected participants to be send home with a £2 show-up fee. The possibility of being send home (due to an exact number of participants being required for the study) was advertised on SONA when participants signed up. Excluding participants happened through a procedure of shuffling a deck of cards (containing the cubicle numbers of all occupied computers) and randomly drawing one or more cards.

At the end of the experiment participants were paid a show-up fee (£2) and an additional performance fee (£0-£20) based on a random lottery incentive system. Deciding the performance fee based on a randomly selected trial is a frequently used

[14] Out of accuracy, we add that if three or more coins are transferred the minimum for the OE is set at zero coins (not at a negative value) since whatever is transferred is ensured to have been in the OE initially and can be deducted without making the OE negative in value.

[15] Note that we have demographics data on three additional subjects since our demographics do not distinguish between the people who participated and those who were send home with a show-up fee...

procedure in the field (Laury, 2005); it encourages subjects to do well on all trials (i.e. making extreme strategies more risky)[16] and helps avoid wealth effects (Cox and Epstein, 1989)[17]. The expected pay-off for the average participant was £11; and the average participant earned £10.66. Participants are told during an introductory PowerPoint explanation that they earn a performance fee based on their payoff in a randomly selected trial with each 'coin' translating to a value of £2; additionally, they are informed of a certain £2 show-up fee. We did not provide participants with details regarding the random selection procedure for the 'performance fee' trial; concretely, a python script randomly selects a trial per participant to base their performance fee on. Different participants can thus be remunerated upon performance in different trials.

Materials

The experiment was performed in the Behavioural Science Lab; the coding was done by the author using a combination of python, HTML/CSS and willow[18]. Participants face a total of twenty trials; and they swap between being in the role of P1 and being in the role of P2 on each consecutive trial to maximize fairness and exposure to both roles. We desired to collect data on all possible scenarios equally often for each participant and thus we controlled the initial value of the OE such that each participant faces the same scenarios equally often in their P1 trials (i.e. with the following amounts found in the OE 2, 2, 3, 3, 4, 4, 5, 6, 7, 8). The initial value of the CE is generated randomly and conforms to the probabilities of encountering each potential value given the specific content from the OE (see Appendix 1.3).

Given our small explorative sample size we subdivided each experimental session into two mini-sessions. Concretely, sessions consist of twelve participants; six of them are placed in 'Mini-Session A' whilst the other six are placed in 'Mini-

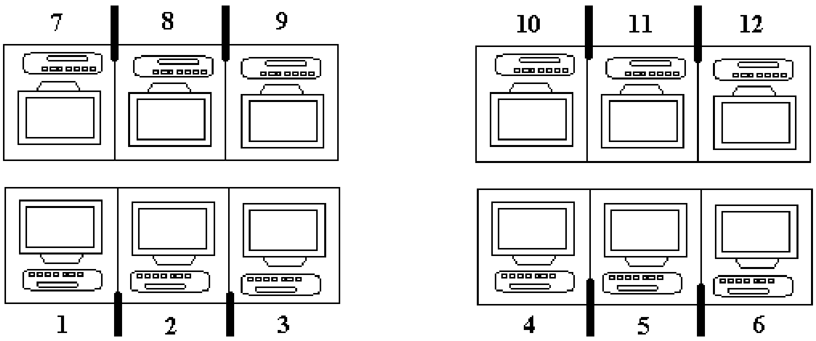
[16] If the performance fee was based on average performance then the effects of extreme strategies would average out whilst now subjects need to decide whether they want to take the risk of an extreme strategy versus play safe.
[17] Wealth effects are scenarios in which behavioural changes occur due to the accumulation of wealth on prior trials or in previous parts of the experiment. When subjects earn money on every trial it is possible for someone who earned a big amount of money early on to take more risk in later trials (compared to someone who earned the minimum).
[18] Willow is a framework used to combine these different languages and allow interactive decision making. Details on willow can be found on: http://econwillow.sourceforge.net/

Session B'. Participants can only be matched with others from the same mini-session. We did not inform participants that they are in one of two mini-sessions as this would affect their perspective on potential opponents to be (re-)matched with. The logic behind these independent mini-sessions is to maintain the same prior experience for participants who are matched together whilst decreasing the risk of biases due to sequence effects (i.e. we now use twice as many randomly generated trial orders). Every trial participants are randomly re-matched and they do not know who they are matched with but they are aware that they are randomly re-matched. We did not drop variables, conditions or trials from our analysis.

Procedure

The experiment consisted of three experimental sessions with exactly twelve participants per session (N=36). A one-hour timeframe was booked for each session but sessions typically finished after 45 minutes. Using an alphabetical listing of signed-up participants we allocated everyone to numbered cubicles. The experiment is set-up such that adjacently seated participants have the same starting role; though they are unaware of this feature (see Figure 21).

Figure 21: Experimental Setup



This figure provides a schematic overview of our experimental layout. Participants sit in two rows of desks each with a computer. Shutters (partitions) are used such that they can only see their own computer. Participants in the same row (e.g. 1-6) start the experiment in the same role.

If more than twelve people showed up we would randomly exclude participants by blindly selecting a cubicle number from a pack of numbered cards after shuffling the cards in front of the participants. Excluded participants received a £2 show-up fee and filled in a payment receipt after which the doors were closed and the experimental setup was explained by means of a PowerPoint presentation (see Appendix 1.4 for details on instructions). The main points from the PowerPoint instructions are shortly summarized below:

> Each trial involves three envelopes containing a number of valuable coins. You are informed that the envelopes have a combined value of twelve coins and that each envelope contains at least two coins initially. You are either assigned the role of Opener (player one) or the role of Chooser (player two). As Opener you are first tasked to select an envelope to Destroy by clicking the button underneath the envelope of choice; this envelope is then destroyed and its contents remain unknown for both players. Next, the Opener selects one of the two remaining envelopes to Open by clicking on the button underneath; the Opener has the privilege to look inside the envelope and he will know the content of the Opened Envelope -- the Chooser does not know its content. The content of the third envelope, the Closed Envelope, is unknown to both players. The final task for the Opener is to decide upon an amount of coins to transfer from the Opened to the Closed Envelope. This amount should be an integer value; it is possible to transfer zero coins or the full value of the Opened Envelope but you cannot transfer more coins than the Opened Envelope contains and you cannot transfer non-integer amounts. Once the Opener typed their desired transfer amount and pressed the 'continue' button their task is done. Next, the Chooser has to make a decision. She sees how many coins are transferred from the Opened to the Closed Envelope. Her task is to decide which of these two envelopes she wants to have for herself (which decides her own payoff) by clicking the button underneath the desired option. The unchosen option is assigned to the Opener (deciding his payoff). Feedback is provided after every trial specifying which envelope you received and what its final contents are; furthermore, feedback also informs you of the envelope received by the other player and its content. After each trial your role swaps (i.e. Openers become Choosers and Choosers become Openers) and you are randomly re-matched with another player for the next trial. A total of twenty trials is played for the experiment. Regarding your final payment you receive a participation fee of £2 and additionally you earn a performance fee based on the amount of coins you win in a randomly selected trial. The performance fee can be anything between zero and twenty pounds and each coin in the experiment is worth exactly two pounds.

Participants were given the opportunity to raise their hand if further clarification was required and were informed that they could do so at any time during the experiment if they had further questions. Before starting the experiment participants were asked to put their electronic devices and notes away. Furthermore, between each experimental cubicle we pulled out ‘shutters’ (i.e. partitions) to avoid the temptation of glancing on a neighbour’s computer screen. At the end of the experiment pay-offs were calculated using a python script. Concretely, the script randomly generates a trial number for each participant and assesses how many coins they won on that particular trial. Coins are multiplied by a factor of two to generate the performance fee and a two pounds show-up fee is added to the total. The python script does this for every participant and makes a clean output file with a summary overview of cubicle numbers and payments.

Whilst the experimenter computed payoffs participants answered hypothetical questions to assess their risk attitude[19]. We assess risk attitude in two different ways (see Appendix 1.5). Firstly, we use a variation on the experimental game in which the participant faces two envelopes and is told that the left envelope contains eight coins whilst the right envelope contains four coins. Furthermore, the participant is informed that the computer will randomly decide whether they receive the left or the right envelope (i.e. they play the role of Opener against Nature). If desired they can transfer coins from the left envelope (with eight coins) to the right envelope (with four coins) before the computer makes this random choice. Based on their decision we assess their risk attitude. Secondly, subjects face three types of lotteries. Each lottery has a specified chance of winning £10 (i.e. the odds are 80%, 50% and 20%) and winning £0 otherwise. For every lottery subjects make multiple decisions regarding their preference for the lottery ticket versus a fixed value. Different fixed values are offered (in random order) until we observe a preference shift in the lottery[20]. We assess the risk attitude based on the indifference point at which participants shift their preferences (an example is provided in Appendix 1.6). Finally, participants fill in receipts for payment and are asked to come forward when we call their cubicle number to receive payment in exchange for their receipt ticket. Data from the experiment is stored in a time-stamped folder containing a multitude of CSV-files (i.e. one for each trial played by each participant ─ this guarantees that not all data would be lost if the program were to somehow malfunction) and these are converted into a big CSV-datafile using a python script. The data is analysed using RStudio.

[19]Notice that subjects are not paid for the risk measurement; wealth effects from the experiment are less likely to influence our risk measurement when it is presented as hypothetical scenarios.
[20] E.g. the subject prefers a lottery ticket over £5 but he prefers £5.5 over the same lottery ticket.

Objectives

Given that this is an exploratory study we assess whether behaviour aligns with predictions from Nash, level k and the maximin principle. Furthermore, we assess whether behavioural patterns can be related to the risk attitude of our participants. This chapter has the following structure. We initially focus on the behaviour of Openers and compare behaviour with the predictions from the three frameworks (both for aggregate and within-subject data). Next, we discuss violations of dominance and focus on behavioural patterns in contexts without dominance. A relationship between the OE-amount and the transfer amount is explored and we assess whether decision time relates to either of these variables. Then, we look at Chooser behaviour. We first assess whether there is a relationship between the transfer amount and envelope selection; and whether decision time relates to either of these variables. Next, we discuss whether dominance is violated and we end the section by comparing the predictions from the three frameworks with observed Chooser-behaviour. Finally, we discuss two risk attitude measurements. A comparison between the two measurements is made; and then we assess whether behaviour of Openers and Choosers differs between subjects that are assessed as purely 'risk averse' (i.e. the majority of our sample) and those that are assessed in another way.

Results

Opener behaviour

We start this section by exploring whether experimental behaviour of the Opener relates to the predictions of the frameworks introduced earlier (i.e. Nash, level k and maximin) by combining suggested strategies into 'profiles'[21]. For each profile we explain its strategy and indicate the corresponding frameworks. We use subscripts for Nash and level k to indicate whether predictions involve a risk averse or risk neutral assumption (see Table 10).

Table 10: Strategy profiles for Openers according to theories and models

[21] Note that we do not assess the more complex 'mixed strategies' that are suggested by Nash. This is true for P1 and P2 across our three chapters – simply since it is hard to assess mixed strategies with our limited data. Furthermore, the existing evidence suggests that human decision makers rarely use mixed strategies and only do so in special types of situations.

	Strategy	Framework
Profile 1	Never transfer coins	$Nash_A$, $Nash_N$, $Level2_A$
Profile 2	If OE=2/3/4: no transfer If OE=5: transfer one or zero coins If OE=6/7/8: transfer one coin	$Level2_N$
Profile 3	If OE=2/3/4: transfer one coin If OE=5/6/7/8: no transfer	$Level4_N$
Profile 4	If OE=2/3/4: no transfer If OE=5: transfer one coin If OE=6: transfer one or two coins If OE=7: transfer two coins If OE=8: transfer three coins	Maximin, $Level1_A$

A summary of the Opener's experimental behaviour is found in Table 11. Concretely, we display for each possible OE-value which proportion of decision resulted into specific transfer amounts[22]. Orange background colours indicate dominated strategies.

Table 11: Splitter behaviour in the envelope game

Amount	Transfer Amount								
OE	0	1	2	3	4	5	6	7	8
2	.63	.33	.04						
3	.66	.31	.03	0					
4	.53	.33	.08	.04	.01				
5	.33	.47	.17	.03	0	0			
6	.14	.56	.28	0	.03	0	0		
7	.19	.39	.25	.11	0	.03	0	.03	
8	.19	.22	.31	.19	.03	.03	0	.03	0

This table provides a summary of Opener behaviour across scenarios. Each row discusses a specific scenario (e.g. two coins are found in the OE) whilst the columns indicate potential transfer amounts. Each cell of the table indicates the proportion of decisions involving a specific OE-amount and a specific transfer amount.

None of these four profiles does a good job at explaining aggregate behaviour on its own. Profile 1 faces the reality that transfers are made and become more frequent when the OE contains larger amounts – in contrast with its 'never transfer' prediction. Profile 2 expected no transfers to be made in cases where the OE contained small values (such as two, three or four coins) but aggregate data suggests that transfers are made in one third of such scenarios. Profile 3 expected no transfers to be made for larger OE-amounts (i.e. five, six, seven or eight coins) whilst a one-coin transfer was expected for small OE-amounts (i.e. two, three or four coins); if anything the general trend of aggregate data is opposite to predictions from Profile 3. Finally, Profile 4 suggested that participants would aim to maximize their minimum

[22] The amounts in the table represent proportions per row since scenarios with two, three and four coins in the OE occur twice as frequent in the experiment compared with the other scenarios; hence, proportions allow a better comparison compared with raw frequencies.

payoff which is in line with the general trend of the aggregate data but fails to explain about one third of our observations. One possible explanation for the data is that different participants may adhere to different strategy profiles. Thus, we next zoom in on the behaviour of individual participants. For each of our 36 participants we assess the frequency in which their Opener-behaviour is in line with each of these four profiles. They each faced ten trials as Opener, however, since trials with two, three or four coins in the OE occur twice as frequent we assess behaviour on a seven-point scale to avoid biasing our assessment due to experimental frequency[23]. An overview of profile adherence can be found in Table 12. We assigned a green background for scores of 5.5 (or more) on the seven-point scale to indicate strong adherence.

Table 12: Qualitatively assessing whether P1s behave according to the four strategy profiles that were deduced from theories and models

Subject	Profile1	Profile 2	Profile 3	Profile 4
0	3.5	4.5	1	5.5
1	3.5	3.5	1.5	4.5
2	3	6	0	6
3	1	1	3	2
4	2	4	2	4
5	2.5	2.5	2	3.5
6	4	5	1	4.5
7	3	4	0	7
8	1.5	1.5	1.5	1.5
9	3	4	2	4
10	3.5	5.5	2	3.5
11	1.5	1.5	2	3.5
12	0	2	3	1
13	1.5	3.5	0.5	4.5
14	4.5	2.5	4	2.5
15	2	4	1	4
16	3	3	2	3
17	3.5	5.5	2	4.5
18	0	2	3.5	1
19	2	4	1	5
20	2.5	4.5	2.5	3.5
21	3	3	4.5	2
22	2.5	3.5	3	4.5
23	4	5	1	5
24	5	4	3.5	3
25	6	3	5.5	2
26	7	4	4	3
27	3	4	2	4
28	0	1	4	1
29	2	6	1.5	4

[23] Concretely, trials in which the OE contains two, three or four coins initially are assigned a 0.5-value for profile adherence whilst trials in which the OE contains five, six, seven or eight coins receive a 1.0-value for profile adherence. Thus, our ten trials are now assessed on a seven-point scale.

30	2.5	4.5	2	2.5
31	2.5	3.5	2	3.5
32	3.5	6.5	1.5	3.5
33	0.5	4.5	3.5	2.5
34	2	6	1.5	4
35	2	4	1	5
mean (Score)	2.68	3.79	2.17	3.57
freq (Score ≥ 5.5)	2	6	1	3

We now provide a descriptive summary of these findings. It seems clear that certain participants show a strong adherence to a specific profile but they are a minority. There were two subjects who fully adhered to the predictions of a specific profile (i.e. Subject26 fully adhered to profile one and Subject7 fully adhered to profile four). In total there were ten participants with an adherence-score of 5.5 (or more) on our seven-point scale. Two of these participants had a high score on two different profiles simultaneously. Furthermore, it appears that strategy profiles two and four (which generally provide the same predictions) are most compatible with experimental behaviour. However, the most stringent finding is that the majority of participants (i.e. 26 out of 36 Openers) does not strongly behave in accordance with any of these profiles across their experimental trials. It is unclear whether they simply behave according to different profiles on different trials or whether they behave in ways that are not predicted by any of these three frameworks[24]. Overall, predictions are not well-satisfied.

To finalize this section we zoom in more deeply on observed behaviour. Concretely, we provide the reader with a short discussion on violations of dominance and take a closer look at behaviour in a non-dominated context without consideration for strategic profiles. Firstly, violations of dominance are occasionally observed but they are uncommon. Since most game-theoretic models consider it irrational to select dominated choices we shortly discuss when these decisions were made. Concretely, Openers should not transfer three coins unless eight coins are found in the OE since the Chooser has a weakly dominant choice whenever a three coin transfer is made (i.e. the CE cannot be worse than the OE in such scenarios). Furthermore, Openers should never transfer more than three tokens since this would involve a strong dominant choice for the Chooser. Looking at our data we observe seven trials in which the Opener transferred more than three coins; such decisions are generally

[24] We inform the reader that we employ a procedure of verbal protocols to help assess thought processes and adherence to theories and models across trials in our next chapter.

made twice by the same participants and the OE typically contained seven or eight coins initially on such trials (see Appendix 1.7). Furthermore, there were 15 trials in which exactly three coins were transferred. Seven of these trials remained viable since the OE initially contained eight coins in which case the two envelopes have an equal value after the transfer; however, eight of these trials involved an initial OE-content that was less than eight coins (implying a violation of dominance). Finally, we take a closer look at non-dominated choices (i.e. when zero, one or two coins are transferred) and the context in which these choices are made (see Table 13).

Table 13: Overview of choice frequencies for all scenarios

Initial amount of coins in OE	Transfer 0	Transfer 1	Transfer 2
2	45	24	3
3	48	22	2
4	38	24	6
5	12	17	6
6	5	20	10
7	7	14	9
8	7	8	11

We performed a one-way repeated measures ANOVA to assess whether a relationship exists between the initial OE-value and the transfer amount, when the transfer amount is less than three coins (i.e. excluding scenarios with dominance). Openers indeed transfer more value when larger amounts are found in the OE ($F_{1,334}$ =33.77, p=1.45 e^{-8}, $\eta^2_{partial}$ =0.092). Additionally, we wondered whether decision speed can be predicted from the initial amount in the OE and the chosen transfer amount when looking at trials in which less than three coins were transferred. After all, previous research through psychology and decisions making (Luce, 1986) has suggested that harder choices are made more slowly. Concretely, we recoded decision times for each individual Opener into z-scores after which we ran a two-way ANOVA. We conclude that the initial amount in the OE does not predict decision time ($F_{6,317}$ =0.617, p=0.012, $\eta^2_{partial}$ =0.022) but that the transfer amount does relate to the decision time variable ($F_{2,317}$ =4.378, p=0.0134, $\eta^2_{partial}$ =0.0287): slower decisions are made when the subject makes larger transfers (i.e. when riskier decisions are made the participant took more time deciding)[25]. This also suggests

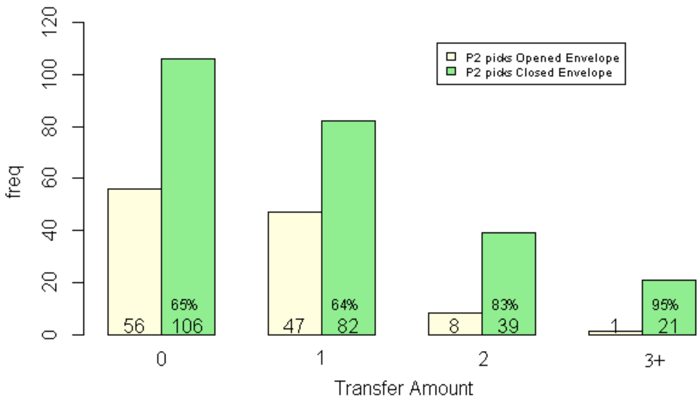
[25] We also checked for a potential interaction effect between the amount in the OE and the transfer amount but such an interaction was not found($F_{12,317}$ =1.956, p=0.028, $\eta^2_{partial}$ = 0.073)

that difficult choices in our experiment are not defined by the amount found in the OE; hard choices are simply those in which the subject takes a higher degree of risk (i.e. decides upon a larger transfer amount). Output files of these ANOVA's can be found in Appendix 1.8.

Chooser behaviour

The experimental behaviour of Choosers is summarized in Figure 22. Concretely, the figure displays the frequency in which the OE versus CE is chosen when zero, one, two or three-plus coins are transferred. Since a transfer of three or more coins results in a dominant choice for the Chooser we merge such scenarios.

Figure 22: Relationship between transfer amount and Chooser's choice



For each of the transfer amounts we observe a preference towards choosing the CE (i.e. the green bars). We ran a repeated measures ANOVA to assess whether there is a relationship between the envelope choice and the transfer amount. We again excluded trials involving dominance (i.e. when three or more coins are transferred) to minimize noise. Results indicate that the CE-preference is not affected by increasing the transfer amount ($F_{1,334}$ =0.043, p=0.836, $\eta^2_{partial}$ =0.00012).

Next, we converted the decision time of individual Choosers into z-scores to assess whether a relationship exists between the transfer amount, the Chooser's decision and her decision time. Our two-way ANOVA excludes trials involving dominance to minimize noise. Its results suggest no relationship between the transfer amount and decision time ($F_{2,326}$ =0.564, p=0.569, $\eta^2_{partial}$ =0.003) and no relationship between the chosen envelope and decision time ($F_{1,326}$ =0.123, p=0.726, $\eta^2_{partial}$ = 0.0003)[26]. Statistical output from these tests can again be found in Appendix 1.8.

Overall the CE is chosen in 496 out of 720 trials (69% of the trials). We point out to the reader that Choosers have a strongly dominant choice when more than three coins are transferred; such scenarios occurred seven times and the Chooser acted in accordance with dominance each time. Furthermore, a transfer of three coins results in a scenario of weak dominance; this scenario occurred fifteen times and Choosers made their choice in accordance with dominance in fourteen of these cases. It is worthwhile to stress that choices in accordance with dominance are not necessarily due to awareness of dominance; these choices may simply be due to a high feeling of risk in relation to the OE since a seemingly large value is transferred. Furthermore, it may be difficult for participants to realise when dominance is involved since this requires a number of calculations[27].

Similarly to our analysis for Openers we summarize potential strategies that Choosers can follow according to popular theories and models; and we indicate which theories or models make these predictions (see Table 14).

Table 14: Strategy profiles for Choosers in the envelope game

	Strategy	Frameworks
Profile 1	Always pick the CE	$Nash_A$, $Nash_N$, $Level1_A$
Profile 2	If no transfer: random If transfer: CE	$Level1_N$, maximin
Profile 3	If no transfer: CE If transfer 1 coin: OE	$Level3_N$
Profile 4	If no transfer: OE If transfer 1 coin: CE	$Level5_N$

We assess whether these three profiles apply to Chooser behaviour on their ten trials. We use a colour coding to indicate profile adherence: blue (profile 1), orange (profile 2), purple (profile 3) or red (profile 4) (see Table 15).

[26] For completeness we add that there is no interaction effect either ($F_{2,326}$ =0.492, p=0.612, $\eta^2_{partial}$ =0.003).

[27] To realise that the CE cannot be worse than the OE whenever three or more coins are transferred it is required that participants compute the maximum OE-value possible. The maximum OE-value is reached whenever the other two envelopes contain the minimum of two coins. Since the total sum equals twelve coins participants would need to deduce that the OE can maximally contain 12-2-2 = 8 coins. Furthermore, participants need to realise that a transfer of three coins from this maximum OE-value of 8 coins results into a remainder of five coins in the OE; whilst such a scenario would imply that the CE has a minimum value of two coins plus the additional (transferred) three coins. This may be too cognitively demanding for experimental subjects to realise.

Table 15: Chooser behaviour within-subject

Subject number	Transfer 0		Transfer 1		Transfer 2		Transfer 3+	
	CE	OE	CE	OE	CE	OE	CE	OE
0	1	5	0	1	0	1	2	0
1	3	2	2	0	2	0	1	0
2	5	0	1	1	2	0	1	0
3	4	1	1	1	2	0	0	1
4	3	2	3	0	0	0	2	0
5	3	1	2	2	1	1	0	0
6	4	0	0	2	2	0	2	0
7	5	2	1	1	0	0	1	0
8	5	2	1	1	1	0	0	0
9	0	2	2	2	3	0	1	0
10	3	2	1	1	3	0	0	0
11	2	1	1	4	0	1	1	0
12	3	0	2	2	0	3	0	0
13	1	2	2	3	2	0	0	0
14	1	1	4	2	2	0	0	0
15	5	0	3	0	1	1	0	0
16	4	0	0	4	0	0	2	0
17	4	2	1	2	1	0	0	0
18	1	0	7	0	0	0	2	0
19	5	0	0	0	4	0	1	0
20	3	0	4	0	2	0	1	0
21	1	5	1	2	0	0	1	0
22	1	2	5	0	1	0	1	0
23	6	0	1	1	2	0	0	0
24	3	1	4	2	0	0	0	0
25	5	1	2	1	1	0	0	0
26	2	2	2	1	3	0	0	0
27	3	1	2	4	0	0	0	0
28	1	1	6	1	0	0	1	0
29	2	1	4	2	1	0	0	0
30	5	4	1	0	0	0	0	0
31	4	5	0	0	1	0	0	0
32	6	1	2	1	0	0	0	0
32	1	1	5	2	0	1	0	0
33	0	6	4	0	0	0	0	0
34	1	0	5	1	2	0	1	0
35	1	5	0	1	0	1	2	0

None of these profiles does a good job at consistently explaining Chooser-behaviour when we do not allow ‘trembling hand’ possibilities. Three participants behaved according to the first profile; four participants behaved according to the second profile, two participants behaved according to the third profile and one participant behaved according to profile four. If we allow minor trembling hand mistakes we find slightly more adherence for profile 1, however, the behaviour of most Choosers remains unexplained.

Risk attitude

Finally, we assess whether there is a relationship between the risk attitude of participants and their experimental behaviour. We assessed risk attitude in two different ways; one version uses a similar design as the experimental game whilst another version calculates the indifference point of participants by looking at preferences between a lottery ticket (which either wins a specific amount of money or wins nothing) versus a certain fixed amount (see Appendix 1.5). We coded each of our 36 subjects once on each risk measurement though the lottery assessment consisted of three lotteries with different probabilities of winning the lottery. Three lotteries were implemented to account for scenarios in which indifference point estimates suggest trembling hand phenomena (i.e. if a subject indicates a preference of £5 for certain over a lottery ticket whilst indicating a preference for the same lottery ticket over a certain £5.50 then clearly a mistake was made). However, the downside of multiple lotteries is that six participants could not be categorized under a ‘pure’ risk attitude due to differential preferences across lotteries. Concretely, behaviour in the “two envelope” measurement is coded as risk averse (RA), risk neutral (RN) or risk seeking (RS); whilst behaviour on the “lottery” measurement also includes mixtures such as RA/NA and RA/RN/RS[28].

Table 16 summarizes how the coding on the two risk attitude measurements overlaps for individual participants.

Table 16: Correspondence between the two envelope and lottery risk attitude measurements

		Overall Lottery Measurement			
		RA	RA/RN	RN	RA/RN/RS
Two Envelopes Measurement	RA	23	3	2	3
	RN	4	0	1	0

Neither assessment involves a pure RS-coding; at best the lottery assessment coded three subjects as a mixture of RA/RN/RS. Furthermore, it is worth noting that the majority of participants is coded as risk averse (i.e. 23 out of 36 subjects were coded ‘RA’ for both assessments) which is in line with past literature (e.g. Dohmen et al., 2011; Holt and Laury, 2002). The main differences between the two

[28] We point out to the reader that the lottery assessment is computed by looking which risk coding occurred the most frequently for each subject across the three lotteries. A three-way tie thus means that the individual was coded as RA, RN and RS once each. A two-way tie is possible whenever an assessment is excluded due to the violation of transitivity (i.e. the trembling hand phenomena described earlier).

assessments can be attributed due to mixed assessments on the lottery coding: 80% of non-mixed assessments overlap between the two measurements suggesting that they generally make the same assessments.

Risk attitude and behaviour by P1

Next, we divided Openers based on their risk attitude (on the overall lottery assessment) into an 'averse' and a 'non-averse' group. The non-averse group includes all mixed codings since only three non-averse participants were considered purely risk neutral (i.e. otherwise our comparison group is too limited). Behaviour from the averse and the non-averse group is compared in Table 17 and Table 18; scenarios involving transfers of more than three coins are excluded from these tables since they violate dominance. The most frequent behavioural tendencies are indicated by an orange background.

Table 17: Averse Opener behaviour (lottery assessment)

Initial amount of coins in the OE	Transfer 0	Transfer 1	Transfer 2	Transfer 3
2	31	20	3	
3	36	16	2	0
4	29	17	4	3
5	11	10	5	1
6	5	17	4	0
7	6	11	6	3
8	5	5	9	6

Table 18: Non-averse Opener behaviour (lottery assessment)

Initial amount of coins in the OE	Transfer 0	Transfer 1	Transfer 2	Transfer 3
2	14	4	0	
3	12	6	0	0
4	9	7	2	0
5	1	7	1	0
6	0	3	6	0
7	1	3	3	1
8	2	3	2	1

When we focus on the most frequent decisions of each row (i.e. orange background colour) we observe a pattern similar to profile two (i.e. risk neutral level two predictions) and profile four for risk averse Openers (i.e. risk averse level one and maximin predictions). The table of 'non-averse' coded Openers illustrates roughly the same pattern; the main difference between the two tables relates to large

OE-values: risk averse Openers appear to have a stronger desire to transfer value compared with non-averse Openers.

Risk attitude and behaviour by P2

Finally, we explored whether ‘risk averse’ participants are more likely to pick the CE as Chooser. The CE always has a higher (or equal) EV compared with the OE and thus it is sensible to assume that a risk averse Chooser would have a stronger CE-preference). We separated data for averse and non-averse coded Choosers (similar as before the non-averse group includes all the mixed assessments); furthermore, we separated data based on coins being transferred versus status quo scenarios (i.e. behavioural differences may only occur if a transfer is made) (see Table 19 and Table 20).

Table 19: Risk attitude and Chooser behaviour when zero coins transferred

	Picked CE	Picked OE
Averse	71	43
Non Averse	75	39

Table 20: Risk attitude and Chooser behaviour when coins are transferred

	Picked CE	Picked OE
Averse	115	41
Non Averse	111	45

Behaviour of averse and non averse Choosers is remarkably similar both when zero coins are transferred and when coins are transferred. Risk averse and non-averse Choosers do not make different choices based on the lottery risk attitude coding.

Conclusion

In this chapter we introduced the reader to a novel sequential game which involves a low degree of knowledge for both of its players. The game structure was analysed through the lenses of three popular frameworks (i.e. Nash equilibrium, level k models and the maximin principle). The author also stressed how complex the calculations of some of these frameworks are (which makes it somewhat implausible that participants approach the task by performing such computations). Intuitively, the

Nash predictions for the Opener have strong appeal as a solution: it simply suggests that he should never make value-transfers (which is a sensible idea due to his lack of perfect information). When we compare experimental behaviour and predicted strategy profiles we only find a minority of participants who behave strongly according to the predictions of a specific framework. It remains unclear how the majority of participants approaches the task – though potentially they might be using a combination of these frameworks.

Other conclusions which we draw from this paper are that participants occasionally violate dominance but not too frequently. Furthermore, it are usually the same individuals who make such decisions twice; additionally all violations against dominance occurred during the first ten trials of the experiment indicating potential learning effects. It is possible that these errors of judgment are due to the difficulty for participants to grasp the underlying structure of the game

When we take a closer look at scenarios without dominance we observe a relationship between the Opener's choice and the scenario he faces. Concretely, Openers transfer more coins when more coins are available in the OE. However, for Choosers the CE-preference (i.e. her decision) is not affected by the transfer amount – when we compare data from trials in which zero, one or two coins are transferred (i.e. without dominance).

Regarding decision times we observed that the decision times of Openers reflect the choices that were contemplated since slower decisions are generally made when he makes larger transfers; however, the scenario he faces (i.e. the initial amount in the OE) does not affect his decision time. For Choosers we do not find a relationship involving her decision time and the scenario or her choice. Finally, we observed that most of our participants are coded as 'risk averse'; risk averse Openers appear to have a stronger desire to transfer value when the OE contains larger amounts (compared to non-averse Openers) but that risk attitude does not affect the behaviour of Choosers.

Chapter 3 Transfer Game: a game of dominance, bluffing and verbal protocols

Abstract

This chapter explores a new competitive game with a simple structure. The predictions of Nash, level k and maximin theorem are explored and we look at behaviour both in a context where options are dominated and in a context where bluffing is possible. Furthermore, in a follow-up experiment we assess the value of verbal protocols for our experimental design.

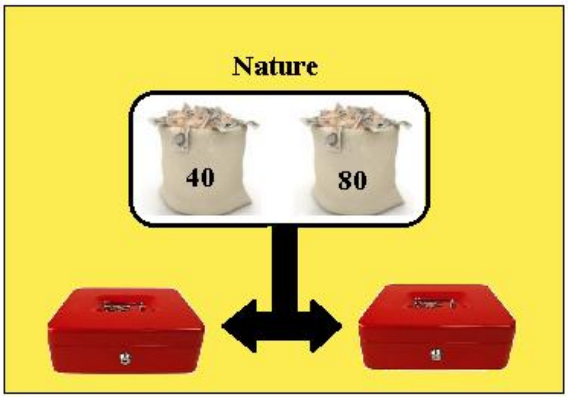
Introduction

In the previous chapter we suggested a risk attitude measurement that consisted of a simple one-shot decision involving two envelopes. Participants knew that the left envelope contained eight coins and that the right envelope contained four coins. They decided how many (if any) coins to transfer from the left envelope (eight coins) to the right envelope (four coins) knowing that one envelope would be randomly selected as their (hypothetical) payoff. Our Transfer Game has a similar design but is framed differently. The choice options are now two boxes (instead of envelopes) and the currency is tokens (instead of coins). Furthermore, amounts are scaled upwards to 80 and 40 (instead of eight and four) and the game is played against a strategic agent (instead of being played against nature). Furthermore, the transfer game involves multiple trials (i.e. forty trials in Experiment Two and six trials in Experiment Three). In the next section we explain the design and point out the (deeper) differences with the two envelope risk measurement.

Paradigm

The transfer game involves two boxes: one box contains 80 tokens whilst the other box contains 40 tokens (see Figure 23).

Figure 23: Background Knowledge in the Transfer Game

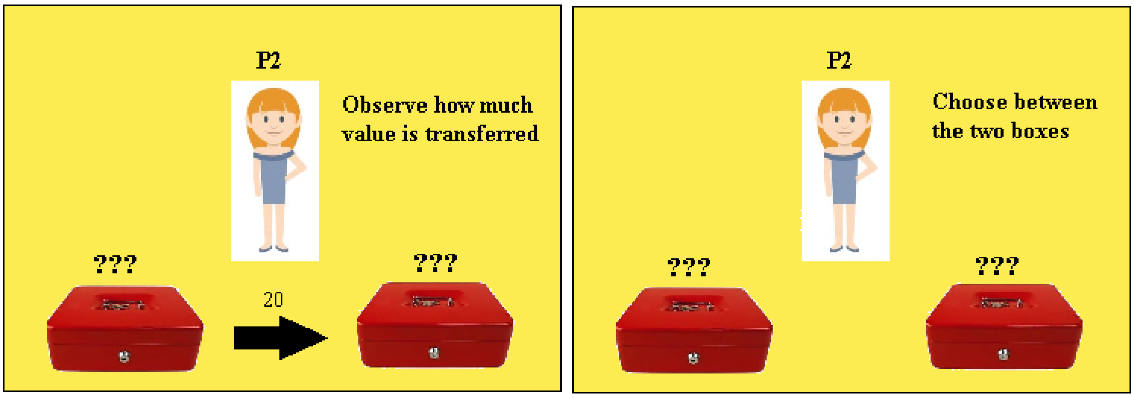


The game starts with the Decider (P1) opening the two boxes and finding out which amount is in which box. In contrast with our game from the previous chapter the transfer amount is now predefined. Concretely, the computer suggests to transfer a specific amount of tokens from ‘Box A’ to ‘Box B’ and P1 decides whether or not to make this transfer (see Figure 24).

Figure 24: Player One Makes His Decision

It is important to realise that the suggested transfer can be from the box with 80 tokens to the box with 40 tokens (i.e. Big to Small; BS) but can also be from the box with 40 tokens to the box with 80 tokens (i.e. Small to Big; SB). Once P1 decides whether or not to make the suggested transfer it is Player Two’s (P2) turn to act. She knows that one box initially contained 40 tokens whilst the other box contained 80 tokens; but she does not know which box contained which amount. She is informed about the suggested transfer (i.e. how many tokens could be transferred and whether this transfer would go in a left-to-right versus a right-to-left direction on the computer screen). Furthermore, she knows whether P1 decided to make this transfer. Her choice is to select whether she wants the box *from* which tokens can be transferred (i.e. Direction From; DF) or the box *to* which tokens can be added (i.e. Direction To; DT) as her own pay-off (see Figure 25). The unchosen box is P1's pay-off.

Figure 25: Player Two Makes Her Decision



There are five important differences between the Transfer Game and the risk measurement from the previous chapter. Firstly, the Transfer Game is played against a strategic agent whilst the risk measurement from the previous chapter involved a random agent. Secondly, the game now involves real pay-offs whilst the risk measurement task involved hypothetical pay-offs. Thirdly, the larger amount (i.e. 80 tokens) can be in either box whilst this was fixed to the left 'envelope' in the risk measurement task. The fourth difference is that the transfer can go either in a Big to Small (BS) directionality or in a Small to Big (SB) directionality whilst the directionality was always BS for the risk measurement task. Finally, the transfer amount is now predefined by nature (i.e. P1 simply decides whether to make the suggested transfer) whilst in the risk measurement task P1 decided himself upon the transfer amount.

Given that our previous chapter signified how only a minority of participants behave according to predictions of popular theoretical frameworks (i.e. Nash equilibrium, level k models and maximin theorem) we investigate in this chapter whether this remains the case when the game structure is simplified and easier to grasp. Concretely, there are only two options (Box A and Box B) and they always hold either (40, 80) or (80, 40) as their respective values at the start of each trial. Furthermore, the decision space for P1 is now heavily constrained to a (make transfer, do not make the transfer) decision compared to him deciding on a numerical amount between two threshold values. This makes interpretation of decisions more straightforward and limits cognitive load by simplifying decisions. To additionally strengthen our conclusions we also explore this game through a verbal protocol approach in a follow-up study.

Links to the literature

We realise that mathematical and quantitative frameworks have offered us many useful insights into matters regarding human behaviour and reasoning. However, we believe that additional insights can be gained by exploring the ways in which participants reason about their task. Thus, in the current chapter we discuss two versions of the Transfer Game; one version is played by individuals (i.e. Experiment Two) whilst the other version is played by two-player teams who communicate through chatting software (i.e. Experiment Three). Usage of chatting software allows us to collect data on experimental reasoning processes. Similar procedures have been explored in the past by other authors. Furthermore, this procedure allows us to explore whether participants consistently reason according to a specific theoretical framework.

Colman, Pulman and Lawrence (2014) indicated how it is theoretically problematic for certain theories to provide explanations for specific coordination games. They created twelve games to compare predictions of team reasoning, strong Stackelberg reasoning and level one and level two reasoning[29]. These games were designed such that there is no strong or weak dominance present. At the end of the experiment participants were provided with a list of eight possible motivations for their choices based on a pilot study. Data was collected on the degree in which participants agreed with the eight motivations and participants were asked to indicate the reasons they used in the order that they were generally employed (if multiple reasons were used). An interesting finding is that most players considered multiple motivations for their choices in the same game (79% of the players in their first experiment and 88% of the players in their second experiment). Furthermore, they realised thanks to the data on motivations that an Avoid The Worst heuristic

[29] They specifically created games in which theories have different predictions and thus they discuss 3x3 and 4x4 experimental games.

(Gigerenzer and Goldstein, 1996) approximates level one reasoning in many of their games; this realisation explains why Avoid The Worst is the most frequently selected motivation for behaviour in their experiment whilst level one reasoning explained decisions the best. Some of the decisions in line with level one reasoning might have been generated by the Avoid The Worst heuristic. Given that Chapter 2 of this thesis suggested that most of our own participants do not behave according to predictions from one specific framework it seems worthwhile to assess choice consistency through the usage of verbal protocols.

One experiment which uses verbal protocols for experimental games is found in Cooper and Kagel (2004). Their main focus was a comparison between teams and individuals in context of a competitive strategic game. They used the entry limit pricing game proposed by Milgrom and Roberts (1982). This game has a monopolist who is either a high cost type or a low cost type and an entrant[30]. The entrant is unaware of the monopolist's type but it is common knowledge that the high and low cost type are equally likely to occur. Monopolists decide between seven possible outputs knowing that their decision is observed by the entrant; the entrant then decides to enter the market or not. It is only profitable for the entrant to enter the market if his opponent is the high cost type but he does not know which type the monopolist is. We do not discuss results from Cooper and Kagel (2004), however, we provide some more details of their procedure of verbal protocol collection to contrast with our own setup in Experiment Three.

Cooper and Kagel (2004) provided feedback after every trial regarding the payoff earned and the monopolist's type (i.e. high versus low cost); however, the authors additionally provided participants with an overview of choices and outcomes from other players in the same trial and with a 'history' of the last three trials that were played[31]. Ourselves we provide solely feedback on the trial that has just been played by the participants themselves. For team coordination Cooper and Kagel (2004) used chatting software to allow anonymous communication and additionally the current choice made by participants and their teammate was highlighted using a blue and pink colouring. Once choices converge there is a four second interval to

[30] We remind the reader that 'type' is a common term used in signalling games to refer to a feature that nature assigns to P1 (e.g. high or low production cost) which P2 cannot assess.

[31] Concretely, additionally to the own scenario and payoff participants receive a summary of experimental behaviour and corresponding outcomes for all the other players in the past trial.

change the decision before it becomes final. If no uniform choice is made in the three minute timeframe then one of the teammates would be randomly selected as 'leader' whose choice becomes the team's decision. Ourselves we also use a chatting room to allow private communication within each team whilst maintaining anonymity. However, we do not use a visual indicator of the current choice selection of teammates because it limits the need for written communication and we want to maximize the frequency in which participants explain their reasoning to teammates. Furthermore, we also use a time limit for team discussion and decision making (i.e. a two minute timer which is displayed on-screen), however, our own setup penalizes lack of coordination by not providing payoffs for trials in which the team did not make a uniform decision within the timeframe.

Assumptions and game structure

We assume that both players are rational agents who aim to maximize their own pay-off (and thus minimize the payoff of their opponent). Furthermore, we assume that behavioural differences for P1 (to whom we refer in this chapter as 'Decider') are due to the transfer amount and transfer direction. Similarly, behavioural differences for P2 (to whom we refer in this chapter as 'Chooser') are assumed to be due to the transfer amount and the Decider's decision (i.e. whether he made the transfer). We remind the reader that suggested transfers either have a BS-directionality (i.e. Big to Small) or a SB-directionality (i.e. Small to Big) which is solely known by the Decider. Furthermore, the transfer amount is predefined in this experiment and is always one of the following amounts: five, ten, twenty, thirty and thirty-five tokens. Both players know the transfer amount and the Chooser knows whether her opponent decided to make the transfer. Her decision is to select either the DT (i.e. Direction To) or DF (i.e. Direction From) box as her own payoff whilst the remaining box is assigned to the Decider. The structure of the game is summarized in Table 21.

Table 21: Structure of the Transfer Game

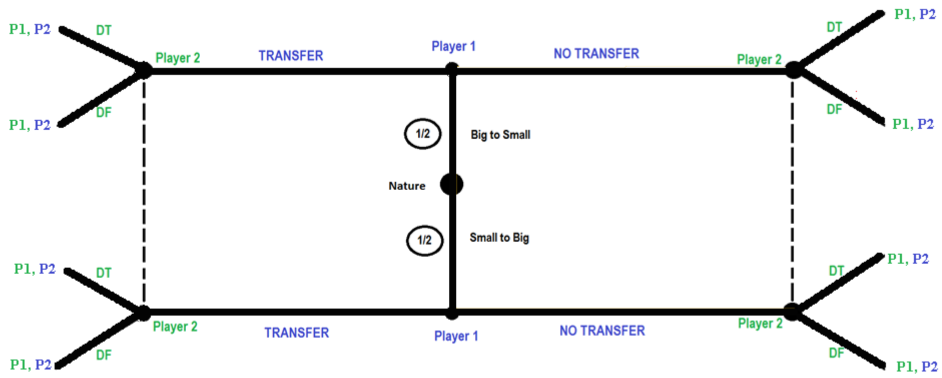
	No transfer		Transfer 5		Transfer 10		Transfer 20		Transfer 30		Transfer 35	
	DF	DT	DF	DT	DF	DT	DF	DT	DF	DT	DF	DT
BS	80	40	75	45	70	50	**60**	**60**	50	**70**	45	**75**
SB	40	80	35	85	30	90	20	**100**	10	**110**	5	**115**

It should be clear that transfers of 20 or more tokens lead to dominant choices for the Chooser (i.e. $DT \geq DF$; as is indicated in the table by a bold font).

Nash predictions

Since the transfer game is a sequential game of imperfect information we explore the Perfect Bayesian Nash Equilibria (PBNE) predictions. In contrast with the experimental game from the previous chapter we now predefined the transfer amount which implies that we have five unique scenarios to discuss (i.e. the transfer amount is always one of the following five, ten, twenty, thirty or thirty-five tokens). However, the reader should be aware that scenarios in which five or ten tokens can be transferred both reflect structures without dominance whilst scenarios in which thirty or thirty-five tokens can be transferred both reflect structures with strong dominance. As a result these scenarios consistently reach the same equilibrium states (but with different parametrical restrictions) and can be discussed together. In Figure 26 we illustrate the structure of the experimental game with all decision nodes including placeholders for the pay-offs (i.e. P1, P2).

Figure 26: Game structure for PBNE analysis



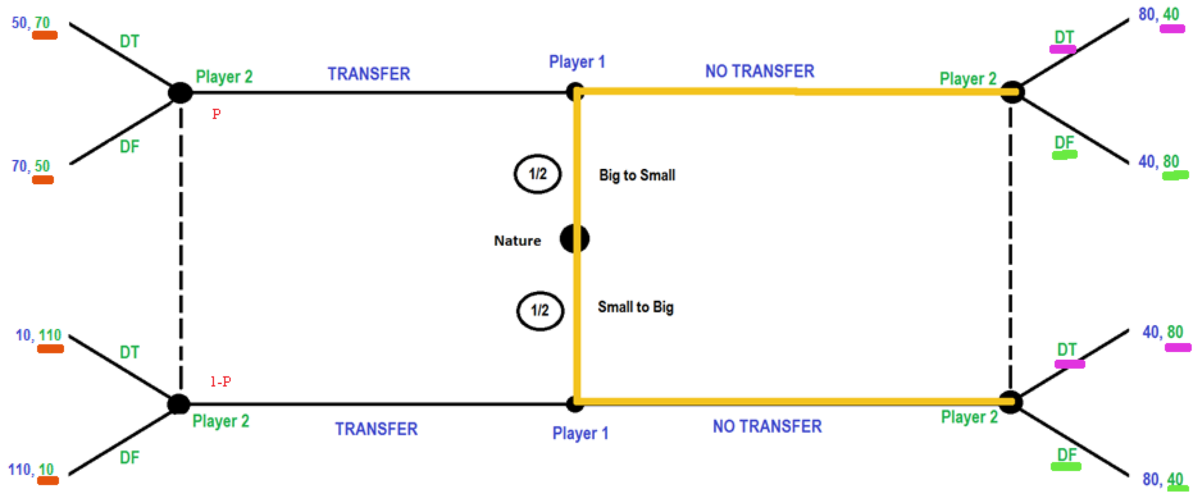
Concretely, nature assigns P1 with a ‘type’ (i.e. BS versus SB) with equal probabilities for each type. P1 decides whether to transfer versus not transfer a specified token amount (i.e. 5, 10, 20, 30 or 35) and P2 decides whether to pick DT versus DF; she knows whether the transfer is made but she does not know P1’s type. We consistently start analysis by assuming that the equilibrium under investigation exists and then we explore step-by-step which parameter values are required for the equilibrium to remain intact under the required assumptions.

Pooling PBNE

We speak of a Pooling PBNE when P1 makes the same decision regardless of his type. The two potential Pooling PBNEs are thus to *transfer regardless the type*; or to *not transfer regardless the type*. It should be straightforward that P2 can exploit a (Transfer, Transfer) strategy by consistently picking DT. Thus, P1 would want to deviate with at least one of his types implying that no such Pooling PBNE can exist. The only possible Pooling PBNE is thus a (No Transfer, No Transfer) strategy. If neither type of P1 transfers tokens then the Expected Payoff for P2 (EP_{P2}) is the same regardless whether she picks DT or DF (i.e. $\frac{40+80}{2}=\frac{80+40}{2}$). She is thus indifferent between DT and DF if no transfer is made which means that she can decide upon any probability (including 100% and 0%) in which to pick DT when no transfer is made.

We start by exploring the scenario of strong dominance since it seems intuitive that P1 should never make transfers in this context. Since the results are the same for 30 and 35 token scenarios we explain the analysis using 30 tokens as an example (though we do provide parameter values for the scenario in which 35 tokens can be transferred whenever an equilibrium is found). Figure 27 Provides the reader with the structure of the game when 30 tokens can be transferred assuming that P1 never makes this transfer (i.e. we start by assuming the existence of the equilibrium and explore whether it is possible to set parameter values such that this equilibrium holds).

Figure 27: Exploring a Pooling PBNE for the transfer amount of 30 tokens



It should immediately be clear that P2 is indifferent between DT and DF when no transfer is made since $EP_{P2}(DT|notransfer)$ = $EP_{P2}(DF|notransfer)$ (see Equation 9)[32].

Equation 9: Expected Payoff (EP) computation if no transfer is made

$$EP_{P2}(DT|notransfer) = \frac{1}{2}40 + \frac{1}{2}80 = 60$$

$$EP_{P2}(DF|notransfer) = \frac{1}{2}80 + \frac{1}{2}40 = 60$$

This means that she can choose DT in any probability she likes – though later on we set restrictions on this probability such that we remain in an equilibrium state. If an off-equilibrium state were reached (i.e. if P1 were to transfer) then we assess P2's beliefs ('p') of being in the BS-Transfer node. We compute the EP_{P2} if she chooses DT versus DF if a transfer is made (see Equation 10).

Equation 10: EP computation based on beliefs if a transfer of 30 tokens can be made

$$EP_{P2}(DT|transfer30) = 70p + 110(1-p) = 110 - 40p$$

$$EP_{P2}(DF|transfer30) = 50p + 10(1-p) = 10 + 40p$$

For P2 to be indifferent between DT and DF the expected payoffs need to be the same. However, this requires the belief $p = \frac{5}{4}$ (i.e. $110 - 40p = 10 + 40p$); since beliefs expresses probabilities it is immediately clear that P2 cannot be indifferent when a transfer is made. Furthermore, she cannot prefer DF in such a scenario since this requires a belief $p > \frac{5}{4}$. The only possible strategy for P2 when a transfer is made is thus to pick DT (i.e. involving the belief $p < \frac{5}{4}$).

Finally, to make sure that P1 cannot gain from off-equilibrium decisions we set the probability 'Q' of P2 choosing DT when no transfer is made (i.e. the equilibrium path) such that Equation 11 holds true.

Equation 11: Setting the probability of P2 picking DT when no transfer is made in such a way that we prevent P1 from deviating from the equilibrium path

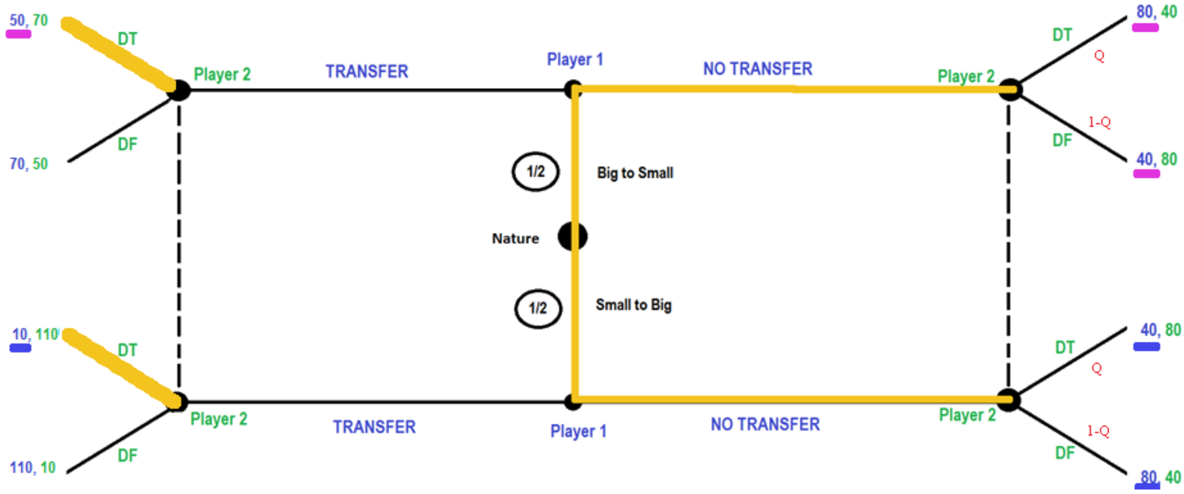
[32] Note that this is the case regardless the transfer amount since the right side of the figure remains the same in all possible scenarios.

$$\mathrm{EP_{P1}}\left(\mathrm{transfer|BS}\right) \leq \mathrm{EP_{P1}}\left(\mathrm{notransfer|BS}\right)$$

$$\mathrm{EP_{P1}}\left(\mathrm{transfer|SB}\right) \leq \mathrm{EP_{P1}}\left(\mathrm{notransfer|SB}\right)$$

Concretely, we set the probability 'Q' such that the expected payoff for P1 ($\mathrm{EP_{P1}}$) is equal or larger when he remains on the equilibrium path compared to when he deviates. Thus, any probability Q in which P2 picks DT (when no transfer is made) that is larger or equal than this threshold value is in equilibrium.

Figure 28: Setting the value for Q such that P1 does not want to deviate



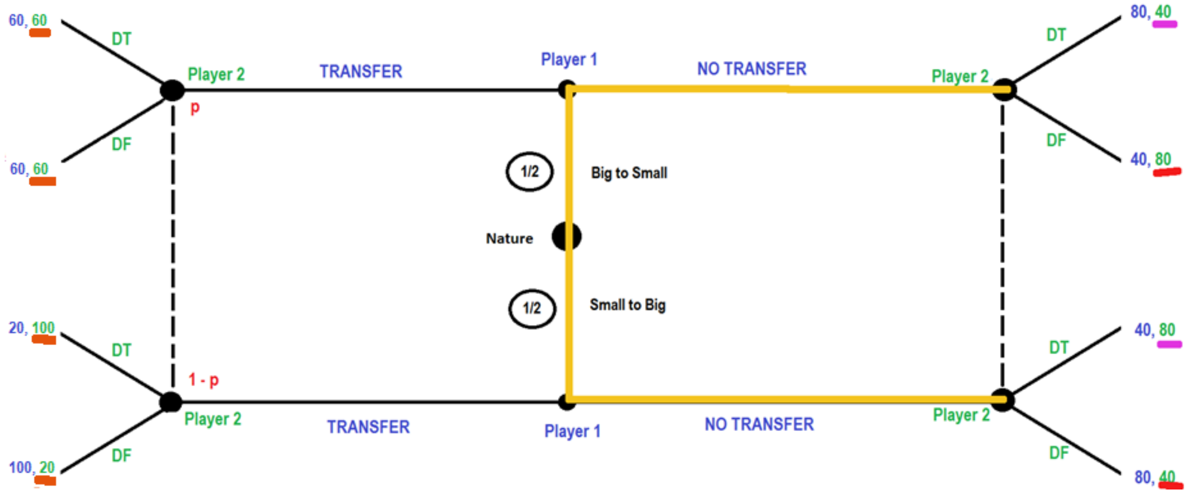
For the BS-type we need to set 'Q' such that $80Q+40(1-Q)\geq 50 \Leftrightarrow Q\geq 0.25$. For the SB-type the same 'Q' needs to be $40Q+80(1-Q)\geq 10 \Leftrightarrow Q\leq 1.75$ (which is true by default since Q is a probability).

Thus, there is a Pooling PBNE in which P2 holds the belief $p<\frac{5}{4}$ such that she always picks DT when a transfer is made (since it consistently leads her to a higher EP) whilst she picks DT with a probability $Q\geq 0.25$ when no transfer is made to prevent P1 from deviating (i.e. if P1 were to deviate his EP would decrease).

The same Pooling PBNE is found when the transfer amount is 35 tokens; however, the parameters are slightly different. When 35 tokens can be transferred P2's belief is $p<\frac{11}{8}$ and she always picks DT when a transfer is made. If no transfer is made she picks DT with a probability of $Q\geq 0.125$ to prevent P1 from deviating.

Next, we assess the same Pooling Equilibrium for scenarios of weak dominance (i.e. when the transfer amount is 20 tokens). Due to the weak dominance a similar equilibrium should exist.

Figure 29: Exploring a Pooling PBNE for transfer amount 20 tokens



Again, P2 is indifferent between DT and DF when no transfer is made since $EP_{P2}\left(DT \mid transfer20\right) = EP_{P2}\left(DF \mid transfer20\right)$. This means that she can choose DT in any probability she likes – though later on we set restrictions on this probability such that we remain in an equilibrium state. If an off-equilibrium state were reached (i.e. if P1 were to transfer) then we need to assess P2's beliefs ('p') of being in the BS-Transfer node. We compute the EP_{P2} if she chooses DT versus DF if a transfer is made (see Equation 12).

Equation 12: Computing P2s belief if 20 tokens are transferred

$$EP_{P2}\left(DT \mid transfer20\right) = 60p + 100(1-p) = 100 - 40p$$

$$EP_{P2}\left(DF \mid transfer20\right) = 60p + 20(1-p) = 20 + 40p$$

For P2 to be indifferent between DT and DF their expected payoffs need to be the same. This requires the belief $p = 1$ (i.e. $100 - 40p = 20 + 40p$); which would mean that P2 is absolutely certain to be in the BS-transfer node. If she has even the slightest doubt she should pick DT ($p < 1$). She should never use a pure strategy of picking DF if a transfer were made since this requires an impossible belief ($p > 1$).

Next, we set the probability 'Q' of P2 choosing DT when no transfer is made such that P1 does not desire to make off-equilibrium decisions (see Equation 13).

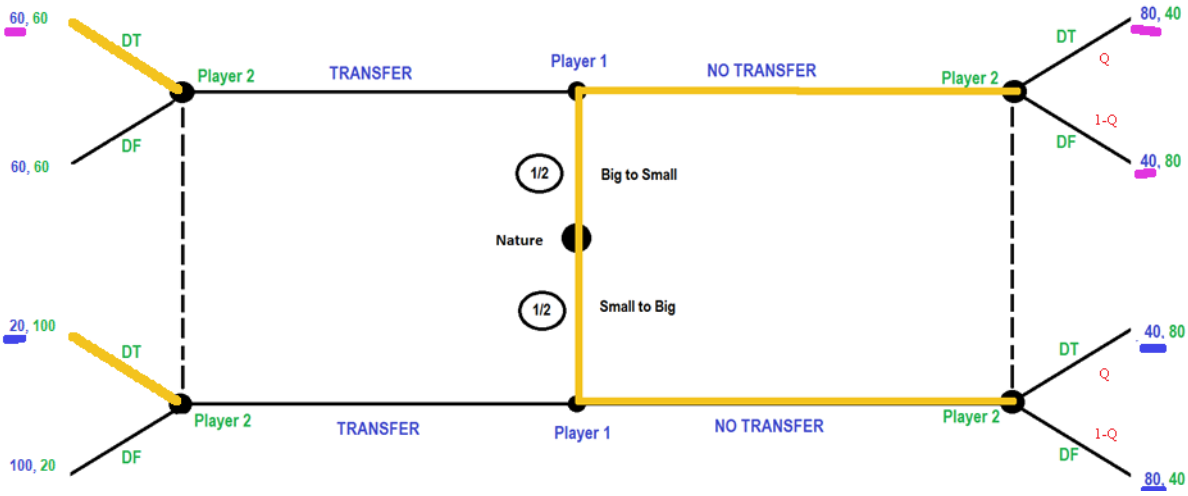
Equation 13: Setting the value for Q such that P1 does not want to deviate

$$EP_{P1}\left(transfer \mid BS\right) \le EP_{P1}\left(notransfer \mid BS\right)$$

$$EP_{P1}\left(transfer \mid SB\right) \le EP_{P1}\left(notransfer \mid SB\right)$$

Concretely, we set the threshold for probability 'Q' such that the EP_{P1} is equal or larger when he remains on the equilibrium path compared to when he deviates. Any probability in which P2 picks DT when no transfer is made that is larger or equal compared to this threshold is in equilibrium. We first explore what probability Q should be in the most extreme scenario, i.e. when P2 consistently picks DT if a transfer is made (see Figure 30).

Figure 30: Setting the value for Q such that P1 does not want to deviate



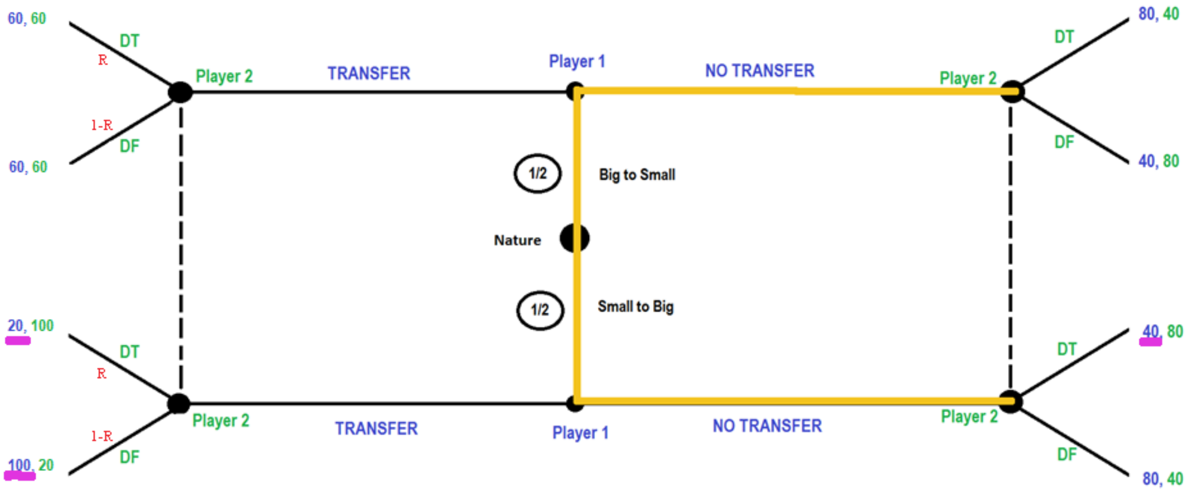
For the BS-type we need to set 'Q' such that $80Q + 40(1-Q) \ge 60 \Leftrightarrow Q \ge 0.50$. For the SB-type the same 'Q' needs to be $40Q + 80(1-Q) \ge 20 \Leftrightarrow Q \le 1.50$ (which is true by default since Q is a probability). Thus, as long as P2 picks DT when no transfer is made with a probability of $Q \ge 0.50$ we have a PBNE.

However, P2 may potentially use a mixed strategy if a transfer is made (if her belief is p=1 she may pick DF when a transfer is made[33]). Concretely, we calculate the probability 'R' in which she should pick DT when a transfer is made such that P1 does not desire to leave the equilibrium path.

[33] Even though this seems somewhat weird due to the weak dominance that involved with a 20 token transfer it remains viable as long as the probability ensures that P1 does not want to deviate.

If P2 picks DT with a probability $Q \geq 0.50$ when no transfer is made the BS-type would never deviate so we only need to consider the SB-type when calculating 'R'. The most extreme scenario that can be in equilibrium is when P2 consistently picks DT when no transfer is made (see Figure 31).

Figure 31: Computing the value of R such that P1 does not want to deviate



Not making the transfer leads to an EP of 40 tokens for the SB-type and thus we need to set 'R' such that the EP for the SB-type is less than or equal to 40 tokens if he were to make the transfer (see Equation 14).

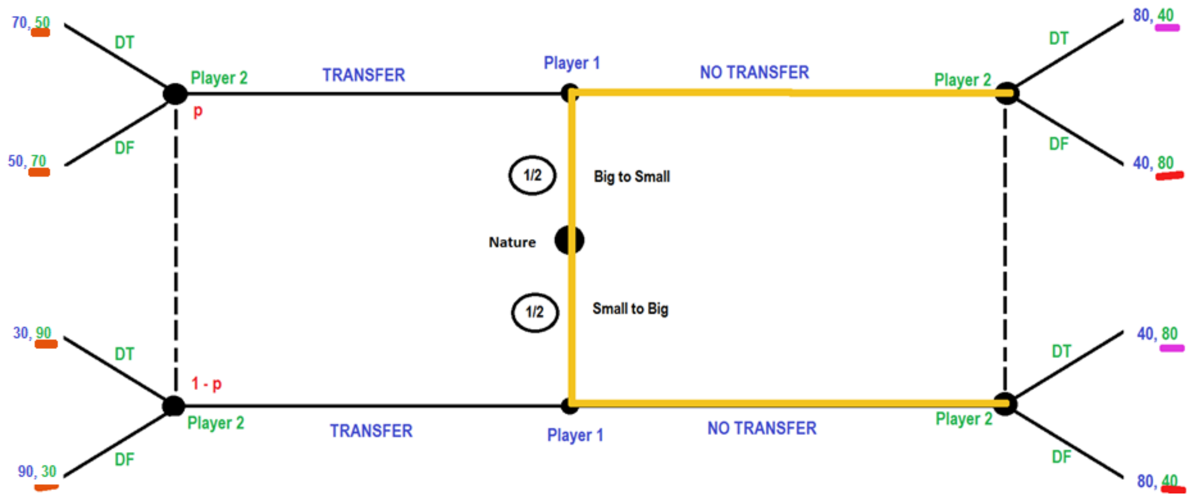
Equation 14: Setting the value of R such that P1 does not want to deviate

$$EP(transfer \mid SB) \leq 40 \Leftrightarrow 20R + 100(1-R) \leq 40 \Leftrightarrow 100 - 80R \leq 40 \Leftrightarrow -80R \leq -60$$
$$\Leftrightarrow R \geq \frac{6}{8} \Leftrightarrow R \geq \frac{3}{4}$$

This means that P2 should choose DT in at least $\frac{3}{4}$ of the cases when a transfer is made to prevent P1 from deviating. In conclusion there is a Pooling PBNE for scenarios involving the transfer amount of 20 tokens. If P2 finds herself of the equilibrium path then her belief to be in the BS-transfer node is $p \leq 1$. Concretely, P2 picks DT with probability $Q \geq 0.50$ if no transfer is made whilst she picks DT with probability $R \geq \frac{3}{4}$ if a transfer is made. As long as these two requirements are met a pooling equilibrium in which P1 never transfers is found.

Finally, we assess whether a Pooling Equilibrium exists for scenarios in which no dominance is involved. We use the scenario with transfer amount 10 as example but the same conclusions hold if the transfer amount was 5 tokens. Based on the previous Pooling Equilibria the reader should have a hunch that a Pooling PBNE also exists in a context without dominance.

Figure 32: Exploring a Pooling PBNE when the transfer amount is 10 tokens



Again, P2 is indifferent between DT and DF when no transfer is made since $\text{EP}_{\text{P2}}\left(\text{DT}|\text{notransfer10}\right)$ = $\text{EP}_{\text{P2}}\left(\text{DF}|\text{notransfer10}\right)$. She can choose DT in any probability she likes – but we restrict this probability to be in an equilibrium state. If an off-equilibrium state were reached (i.e. if P1 were to transfer) then we assess P2's beliefs ('p') of being in the BS-Transfer node. We compute the EP_{P2} if she chooses DT versus DF if a transfer is made (see Equation 15).

Equation 15: Computing EP for P2 if a transfer is made

$$\text{EP}_{\text{P2}}\left(\text{DT}|\text{transfer10}\right) = 50p+90(1-p)=90-40p$$

$$\text{EP}_{\text{P2}}\left(\text{DF}|\text{transfer10}\right) = 70p+30(1-p)=30+40p$$

For P2 to be indifferent between DT and DF the EP of both choices need to be the same. This requires the belief $p=\frac{3}{4}$ (i.e. $90-40p=30+40p$); furthermore P2 has a preference towards DF if $p>\frac{3}{4}$ and P2 has a preference towards DT if $p<\frac{3}{4}$. However, P2 should not have a belief favouring DF consistently as this would cause the SB-type to deviate from the equilibrium path – since EP_{P1}(transfer|SB) would be larger than EP_{P1}(notransfer|SB) regardless the choice that P2 makes on the equilibrium path (i.e. $90 > 40$ and $90 > 80$). Thus, to have an equilibrium P2's belief has to be restricted such that $p \le \frac{3}{4}$.

Next, we set the probability 'Q' of P2 choosing DT when no transfer is made such that P1 does not desire to make off-equilibrium decisions (see Equation 16).

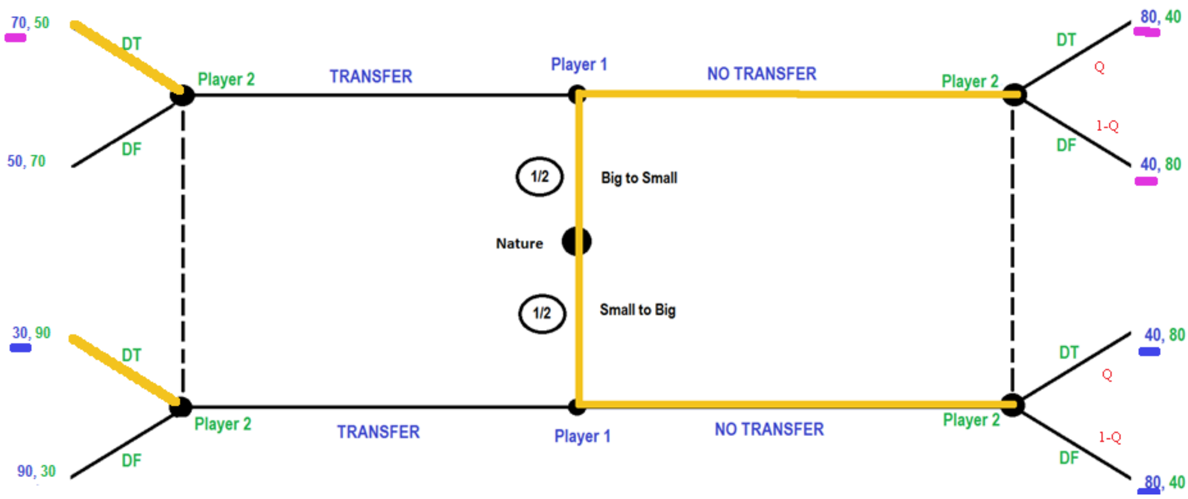
Equation 16: Setting Q

$$\mathrm{EP_{P1}}\left(\mathrm{transfer|BS}\right) \le \mathrm{EP_{P1}}\left(\mathrm{notransfer|BS}\right)$$

$$\mathrm{EP_{P1}}\left(\mathrm{transfer|SB}\right) \le \mathrm{EP_{P1}}\left(\mathrm{notransfer|SB}\right)$$

Concretely, we set the threshold for probability 'Q' such that the $\mathrm{EP_{P1}}$ is equal or larger when he remains on the equilibrium path compared to when he deviates. Any probability in which P2 picks DT when no transfer is made that is larger or equal compared to this threshold is in equilibrium. We first explore what probability Q should be in the most extreme scenario, i.e. when P2 consistently picks DT if a transfer is made (see Figure 33)

Figure 33: Setting the value of Q such that P1 does not want to deviate

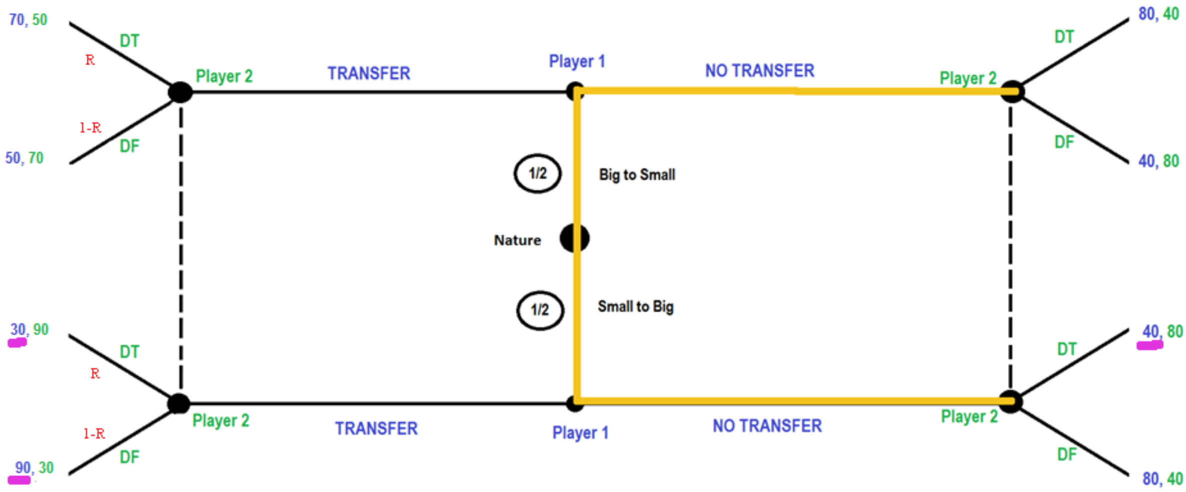


For the BS-type we need to set 'Q' such that $80Q + 40(1-Q) \ge 70 \Leftrightarrow Q \ge 0.75$. For the SB-type the same 'Q' needs to be $40Q + 80(1-Q) \ge 30 \Leftrightarrow Q \le 1.25$ (which is true by default since Q is a probability). Thus, as long as P2 picks DT when no transfer is made with a probability of $Q \ge 0.75$ we can have a PBNE.

However, P2 may use a mixed strategy if a transfer is made if her belief is $p = \frac{3}{4}$. Concretely, we calculate the probability 'R' in which she is allowed to pick DF when a transfer is made such that P1 still does not desire to leave the equilibrium path.

When P2 picks DT with a probability $Q \geq 0.75$ when no transfer is made the BS-type would never deviate[34] so we only need to consider the SB-type when calculating 'R'. The most extreme scenario that is possibly in equilibrium is when P2 always picks DT when no transfer is made (see Figure 34).

Figure 34: Computing value of R such that P1 does not want to deviate



This leads to an EP of 40 tokens for the SB-type and thus we set 'R' such that the EP for the SB-player is less than or equal to 40 tokens when he makes the transfer (see Equation 17).

Equation 17: Setting the value of R such that P1 does not want to deviate

$$EP(transfer \mid SB) \leq 40 \Leftrightarrow 30R + 90(1-R) \leq 40 \Leftrightarrow 90 - 60R \leq 40 \Leftrightarrow -60R \leq -50$$
$$\Leftrightarrow R \geq \frac{5}{6}$$

Thus, as long as P2 picks DT with a probability $R \geq \frac{5}{6}$ there is no reason for P1 to deviate from the equilibrium path. In conclusion there is a Pooling PBNE for

[34] Since the EP for the BS-type would be 70 (or more) if he does not transfer – given that P2 picks DT with a probability of 75% (or more) in scenarios of no transfer – whilst his EP of transferring is 70 tokens at most (i.e. if P2 consistently picks DT if a transfer is made P1 would receive 70 tokens as a transferring BS-type; now, however, we consider P2 who mixes strategy if a transfer is made which would decrease this EP-value).

scenarios without dominance as illustrated by the 10 token transfer amount. If P2 finds herself off the equilibrium path then her belief of being on the BS-transfer node is $p \leq \frac{3}{4}$. Concretely, P2 picks DT with probability $Q \geq 0.75$ if no transfer is made whilst she picks DT with probability $R \geq \frac{5}{6}$ if a transfer is made. As long as these two requirements are met a pooling equilibrium in which P1 never transfers is found.

The same Pooling PBNE is found when the transfer amount is 5 tokens; the parameters are then: belief $p \leq \frac{5}{8}$, probability of P2 picking DT if no transfer is made $Q \geq 0.875$ and probability of P2 picking DT if a transfer is made $R \geq \frac{9}{10}$.

Separating PBNE

There are two pure strategies in this game that are potential Separating PBNEs. Firstly, if P1 transfers as BS-type whilst he does not transfer as SB-type; secondly, if P1 does not transfer as BS-type whilst he transfers as SB-type. Since P2 can deduce P1's type based on his decision, she can consistently pick the better pay-off option – which implies that P1 wants to deviate (with at least one of his types). Therefore, there cannot be a Separating PBNE in this design.

Semi-Separating PBNE

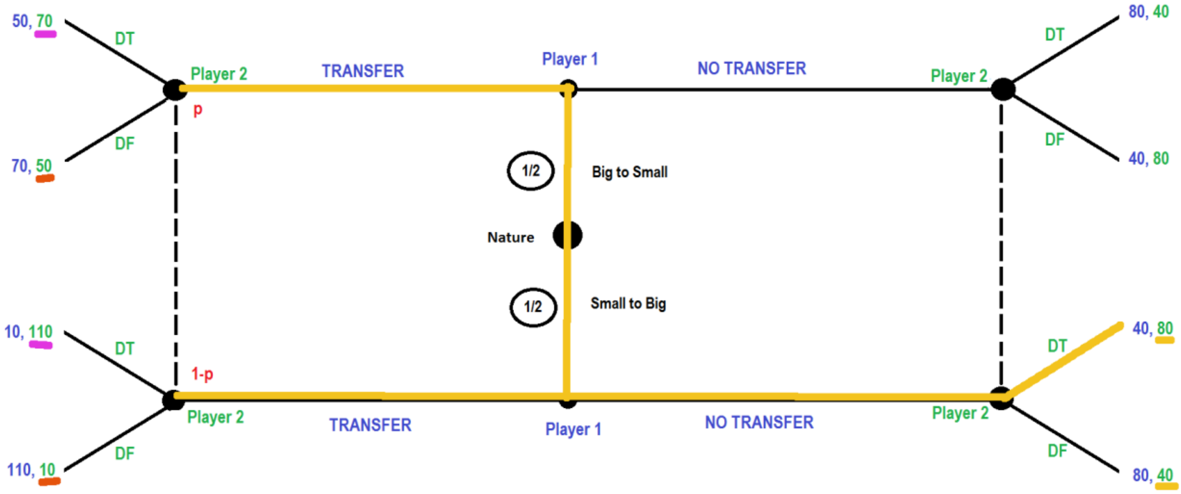
Semi-Separating PBNE's are those in which one type employs a mixed strategy whilst the other type employs a pure strategy. An example is found if the BS-type transfers in some (but not all) occasions whilst the SB-type never transfers. In our design there are four potential semi-separating PBNE's for each of the transfer amounts.

(a) First potential Semi-Separating PBNE: "Transfer if BS; Mixed Strategy if SB".

For each of the transfer amounts P2 would make a DT choice if no transfer is made (since she can infer to be in the "SB, No Transfer" node if this PBNE exists); if a transfer is made P2s beliefs ('p') should be such that she is indifferent between DT and DF for the semi-separating PBNE to exist.

First we assess the scenario of strong dominance using the example in which the transfer amount is 30 tokens (see Figure 35 and Equation 18)

Figure 35: Transfer if BS; Mixed Strategy if SB: example transfer amount 30



Equation 18: P2s beliefs have to make her indifferent between DT and DF for the Semi-Separating PBNE to exist

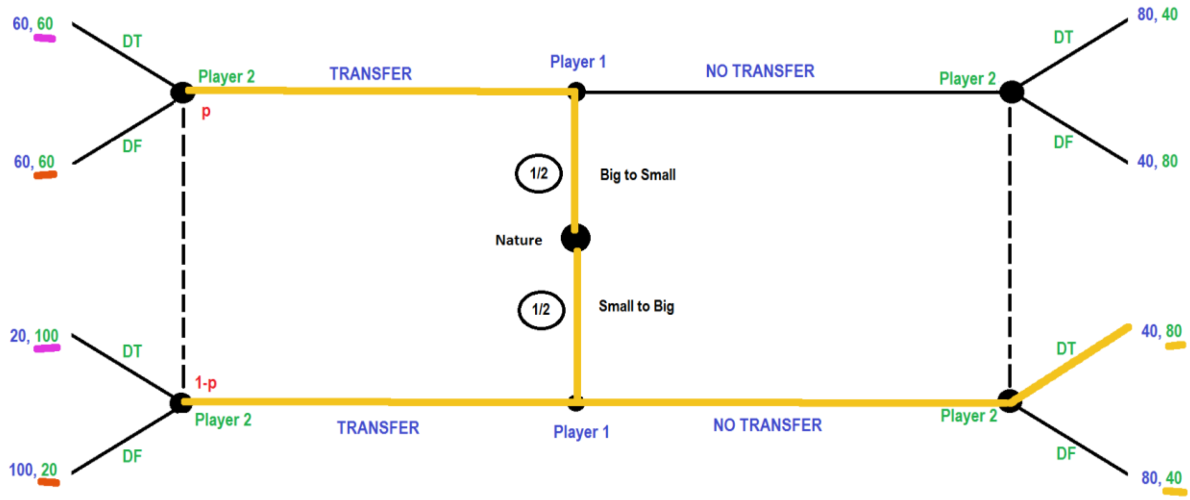
$$EP_{P2}\left(DT \mid transfer30\right) = 70p + 110(1-p) = 110 - 40p$$

$$EP_{P2}\left(DF \mid transfer30\right) = 50p + 10(1-p) = 10 + 40p$$

P2 is indifferent between DT and DF if $110 - 40p = 10 + 40p \Leftrightarrow 100 = 80p \Leftrightarrow p = \frac{5}{4}$. Since the belief ‘p’ cannot be set at a value higher than one there is no such Semi-Separating PBNE possible. The same holds true for the scenario in which 35 tokens can be transferred.

Next, we look at the scenario of weak dominance (see Figure 36 and Equation 19).

Figure 36: Transfer if BS; Mixed Strategy if SB: example transfer amount 20



Equation 19: P2s beliefs have to make her indifferent between DT and DF for the Semi-Separating PBNE to exist

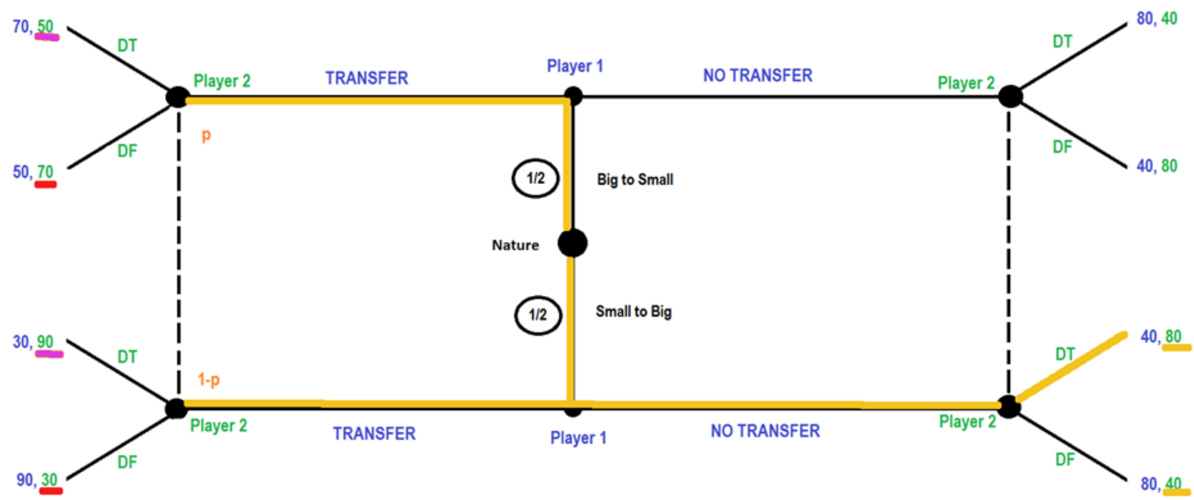
$$EP_{P2}\left(DT \mid transfer20\right) = 60p + 100(1-p) = 100 - 40p$$

$$EP_{P2}\left(DF \mid transfer20\right) = 60p + 20(1-p) = 20 + 40p$$

P2 is indifferent between DT and DF if $100-40p = 20+40p \Leftrightarrow 80 = 80p \Leftrightarrow p = 1$. This does not lead to a Semi-Separating PBNE since P2 has the belief that transfers are made solely by BS-type opponents ($p=1$) which contradicts the assumption of SB-type players using a mixed strategy.

Finally, we explore the scenario without dominance using the example in which 10 tokens can be transferred (see Figure 37 and Equation 20).

Figure 37: Transfer if BS; Mixed Strategy if SB: example transfer amount 10



Equation 20: P2s beliefs have to make her indifferent between DT and DF for the Semi-Separating PBNE to exist

$$EP_{P2}\left(DT \mid transfer10\right) = 50p + 90\left(1-p\right) = 90 - 40p$$

$$EP_{P2}\left(DF \mid transfer10\right) = 70p + 30\left(1-p\right) = 30 + 40p$$

P2 is indifferent between DT and DF $\Leftrightarrow 90-40p = 30+40p \Leftrightarrow 60 = 80p \Leftrightarrow p = \frac{3}{4}$

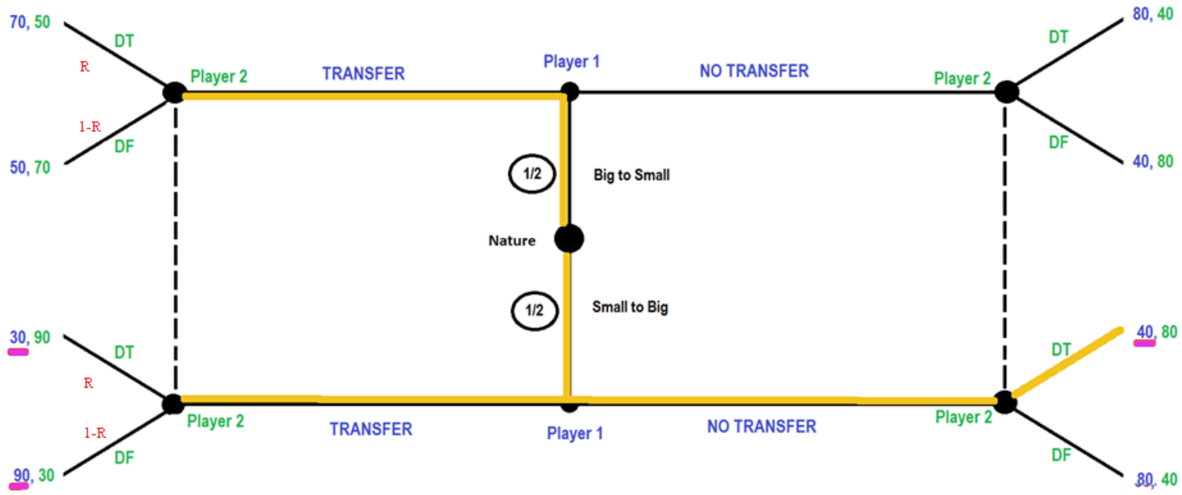
Next we compute the mixed strategy that P1 should use for this PBNE to exist; we use Bayes' rule (see Equation 21).

Equation 21: Using Bayes' Rule We Compute the Mixed Strategy for P1

$$p = \frac{3}{4} = \frac{prob_{BS} \times prob_{transfer|BS}}{prob_{BS} \times prob_{transfer|BS} + prob_{SB} \times prob_{transfer|SB}} =$$

$$\frac{\frac{1}{2}\times 1}{\frac{1}{2}\times 1 + \frac{1}{2}\times prob_{transfer|SB}} \Leftrightarrow \frac{3}{4}\times(1+prob_{transfer|SB}) = 1 \Leftrightarrow prob_{transfer|SB} = \frac{4}{3} - 1 = \frac{1}{3}$$

Figure 38: Solving for the probability ('R') of P2 choosing DT if a transfer is made



Finally, we solve for the probability of P2 choosing DT if a transfer is made ('R'); it is essential that P1 expects the same pay-off in each scenario regardless P2s choices – or else P1 would deviate from using a mixed strategy (see

Equation 22).

Equation 22: Solving for the probability of P2 choosing DT if a transfer is made

$$EP_{P1}\left(transfer \mid SB\right) = EP_{P1}\left(notransfer \mid SB\right)$$

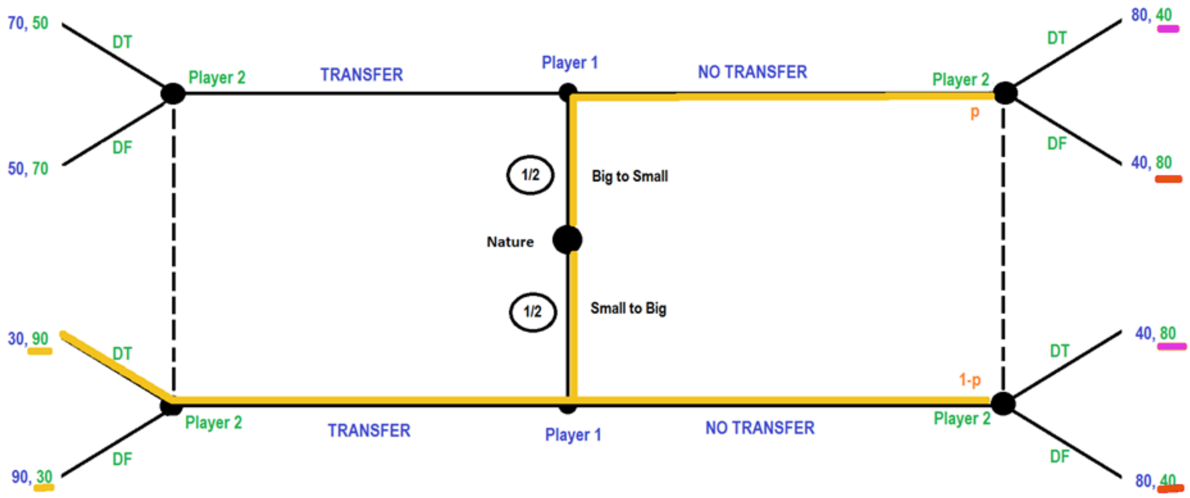
$$\Leftrightarrow 30R+90(1-R)=40 \Leftrightarrow\ 90-60R=40 \Leftrightarrow\ 50=60R \Leftrightarrow\ R=\frac{5}{6}$$

We conclude that there is a Semi-Separating PBNE when 10 tokens are transferred. The PBNE is such that the BS-type player always transfers whilst the SB-type player uses a mixed strategy of transferring in $\frac{1}{3}$ cases. P2s beliefs are that $p=\frac{3}{4}$ and thus P2 will choose DT with a probability of $R=\frac{5}{6}$ if a transfer is made. If no transfer is made then P2 chooses DT. The same Semi-Separating PBNE is found when 5 tokens are transferred. P1 then uses a mixed strategy of transferring in $\frac{3}{5}$ cases. P2s beliefs are $p=\frac{5}{8}$ and P2 will choose DT with a probability of $R=\frac{9}{10}$ if a transfer is made. If no transfer is made then P2 chooses DT.

(b) Second potential Semi-Separating PBNE: “No Transfer if BS; Mixed Strategy if SB”.

For each of the transfer amounts P2 would make a DT choice if a transfer is made (since she can infer to be in the “SB, Transfer” node if this PBNE exists); if no transfer is made P2’s beliefs (‘p’) should be such that she is indifferent between DT and DF for the Semi-Separating PBNE to exist (see Figure 39 for an example).

Figure 39: No Transfer if BS; Mixed Strategy if SB: example transfer amount 10

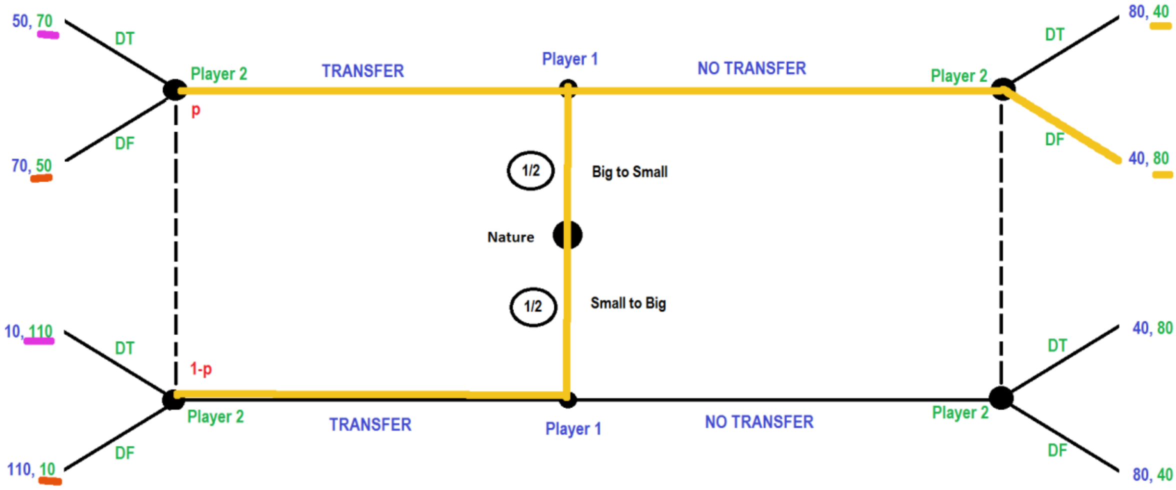


It should immediately be clear that none of the transfer amounts leads to a Semi-Separating PBNE in which P1 follows this strategy as the SB-type of P1 wants to deviate to not transferring since the minimum he can receive from not transferring is already larger than his EP of transferring (i.e. $30 < 40$ in the example below; if the transfer amount were larger the same desire holds but the numbers become more extreme e.g. $20 < 40$ (i.e. for transfer amount 20) and $10 < 40$ (i.e. for transfer amount 30)).

(c) Third potential Semi-Separating PBNE: "BS: mix, SB: transfer"

For each of the transfer amounts P2 would make a DF choice if no transfer is made (since she can infer to be in the "BS, No Transfer" node if this PBNE exists); if a transfer is made P2s beliefs ('p') should be such that she is indifferent between DT and DF for the Semi-Separating PBNE to exist. First, we assess whether this structure leads to a Semi-Separating PBNE under strong dominance using the example in which the transfer amount is 30 tokens. P2 would make a DT choice if no transfer is made (since she can infer to be in the "SB, No Transfer" node if this PBNE exists); if a transfer is made P2s beliefs ('p') should be such that she is indifferent between DT and DF for the Semi-Separating PBNE to exist (see Figure 40 and Equation 23).

Figure 40: Mixed Strategy if BS; Transfer if SB: example transfer amount 30



Equation 23: P2s beliefs have to make her indifferent between DT and DF for the Semi-Separating PBNE to exist

$$EP_{P2}\left(DT \mid transfer30\right) = 70p + 110(1-p) = 110 - 40p$$

$$EP_{P2}\left(DF \mid transfer30\right) = 50p + 10(1-p) = 10 + 40p$$

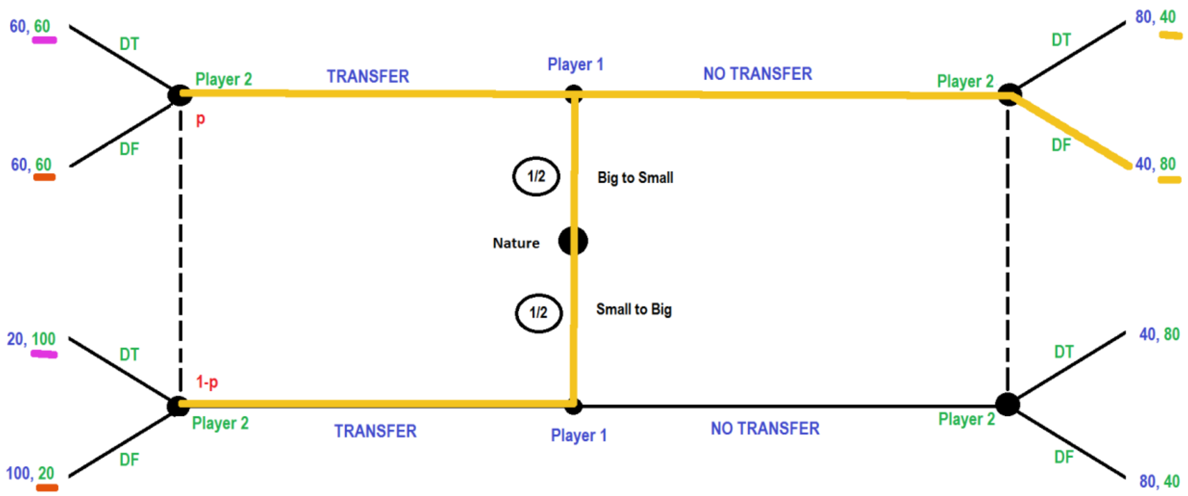
Thus P2 is indifferent between DT and DF if $110-40p=10+40p \Leftrightarrow 100=80p \Leftrightarrow$

$$p=\frac{5}{4}.$$

Since the belief 'p' expresses a probability it cannot be set at a value higher than one; hence, there is no PBNE. The same is true when the transfer amount is 35.

Next we assess whether there is such a PBNE for scenarios of weak dominance. If no transfer is made then P2 picks "DF" (since she can deduce to be in the BS-no transfer node). If a transfer is made P2s beliefs ('p') should be such that she is indifferent between DT and DF for the Semi-Separating PBNE to exist (see Figure 41 and Equation 24).

Figure 41: Mixed Strategy if BS; Transfer if SB: example transfer amount 20



Equation 24: P2s beliefs have to make her indifferent between DT and DF for the Semi-Separating PBNE to exist

$$EP_{P2}\left(DT \mid transfer20\right) = 60p+100(1-p)=100-40p$$

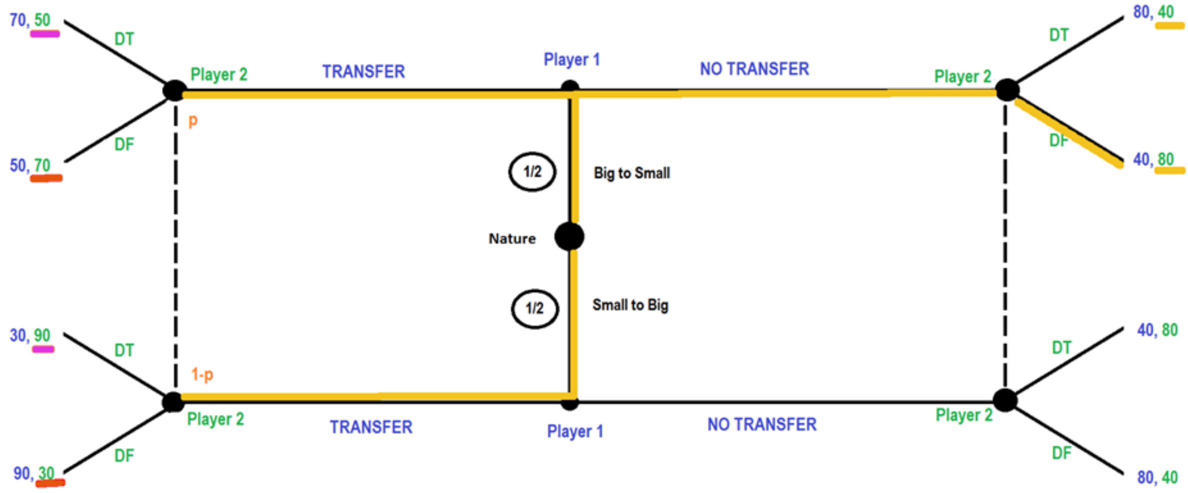
$$EP_{P2}\left(DF \mid transfer20\right) = 60p+20(1-p)=20+40p$$

P2 is indifferent between DT and DF if $100-40p=20+40p \Leftrightarrow 80=80p \Leftrightarrow p=1$

This cannot be a Semi-Separating PBE since P2 beliefs are such that a transfer is made solely when P1 is the BS-type ($p=1$) which contradicts the suggested PBNE structure.

Finally, we explore the scenario without dominance using the example in which 10 tokens can be transferred (see Figure 42).

Figure 42: Mixed Strategy if BS; Transfer if SB: example transfer amount 10



For the Semi-Separating PBE to exist we will need to set P2's beliefs ("p") such that she is indifferent between choosing DT and DF when a transfer is made (see Equation 25).

Equation 25: P2s beliefs have to make her indifferent between DT and DF for the Semi-Separating PBNE to exist

$$EP_{P2}\left(DT \mid transfer10\right) = 50p + 90(1-p) = 90 - 40p$$

$$EP_{P2}\left(DF \mid transfer10\right) = 70p + 30(1-p) = 30 + 40p$$

P2 is indifferent between DT and DF if $90 - 40p = 30 + 40p \Leftrightarrow 60 = 80p \Leftrightarrow p = \frac{3}{4}$

Next, we compute which mixed strategy P1 should use for this PBNE to exist; we use Bayes' rule (see Equation 26).

Equation 26: Using Bayes' Rule We Compute the Mixed Strategy for P1

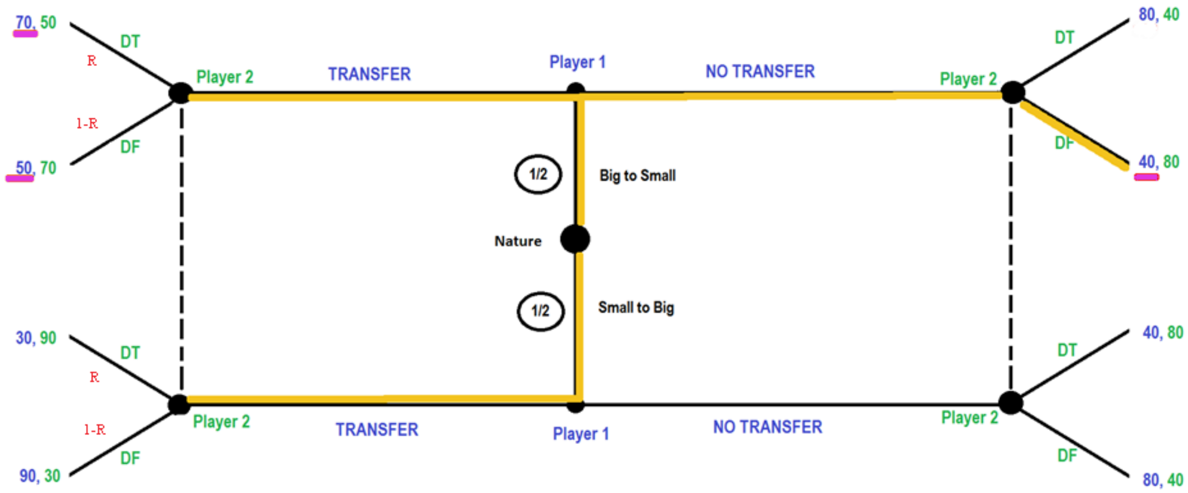
$$\mathbf{P} = \frac{3}{4} = \frac{prob_{SB} \times prob_{transfer|SB}}{prob_{BS} \times prob_{transfer|BS} + prob_{SB} \times prob_{transfer|SB}} =$$

$$\frac{\frac{1}{2} \times 1}{\frac{1}{2} \times 1 + \frac{1}{2} \times prob_{transfer|BS}} \Leftrightarrow \frac{3}{4} \times (1 + prob_{transfer|BS}) = 1 \Leftrightarrow prob_{transfer|BS} = \frac{4}{3} - 1 = \frac{1}{3}$$

Finally, we solve for the probability of P2 choosing DT if a transfer is made ('R'); it is essential that P1 expects the same pay-off in each scenario regardless P2s choices – or else P1 would deviate from using a mixed strategy (see Figure 43 and

Equation 27).

Figure 43: Solving for probability ('R') of P2 picking DT if a transfer is made



Equation 27: Solving for probability of P2 choosing DT if a transfer is made

$$EP_{P1}\left(transfer \mid BS\right) = EP_{P1}\left(notransfer \mid BS\right) \Leftrightarrow 70R + 50\left(1 - R\right) = 40 \Leftrightarrow$$

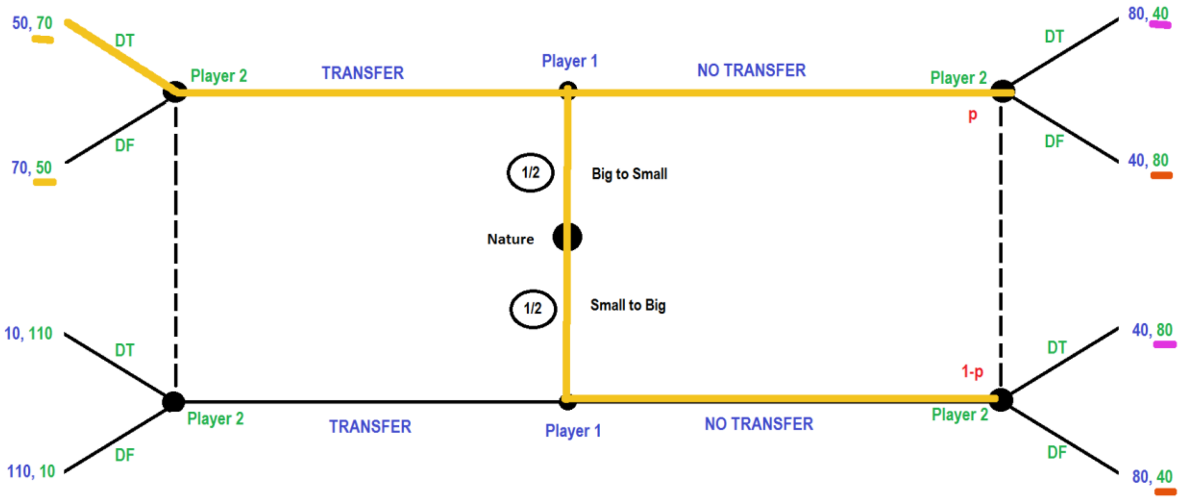
$$50 + 20R = 40 \Leftrightarrow 10 = -20R \Leftrightarrow R = -\frac{1}{2}$$

Since ‘R’ is a probability it cannot be negative; hence, there is no Semi-Separating PBNE involving this structure for the transfer amount of 10 tokens. The same holds true for the scenario in which 5 tokens can be transferred.

(d) Fourth Potential Semi-Separating PBNE: “No Transfer if SB, mixed strategy if BS”

For each of the transfer amounts P2 would make a DF choice if a transfer is made (since she can infer to be in the “BS, Transfer” node if this PBNE exists); if no transfer is made P2s beliefs (‘p’) should be such that she is indifferent between DT and DF for the Semi-Separating PBNE to exist. First, we assess whether there is a Semi-Separating PBNE for transfer amount 30 in which the BS-type uses a mixed strategy whilst the SB-type never transfers. If a transfer is made then P2 picks DT since she can infer to be in the BS-transfer node for which DT offers her a better payoff. If no transfer is made then her beliefs (‘p’) should make her indifferent between DT and DF in order for the Semi-Separating PBNE to exist (see Figure 44 and Equation 28).

Figure 44: Mixed Strategy if BS; No Transfer if SB: example transfer amount 30



Equation 28: P2s beliefs have to make her indifferent between DT and DF for the Semi-Separating PBNE to exist

$$EP_{P2}\left(DT \mid notransfer30\right)) = 40p + 80(1-p) = 80 - 40p$$

$$EP_{P2}\left(DF \mid notransfer30\right) = 80p + 40(1-p) = 40 + 40p$$

P2 is indifferent between DT and DF if $80 - 40p = 40 + 40p \Leftrightarrow 40 = 80p \Leftrightarrow p = \frac{1}{2}$

Next we compute the mixed strategy that P1 should use for this PBNE to exist; we use Bayes' rule (see Equation 29).

Equation 29: Using Bayes' Rule We Compute the Mixed Strategy for P1

$$p = \frac{1}{2} = \frac{prob_{BS} \times prob_{notransfer|SB}}{prob_{BS} \times prob_{notransfer|BS} + prob_{SB} \times prob_{notransfer|SB}} =$$

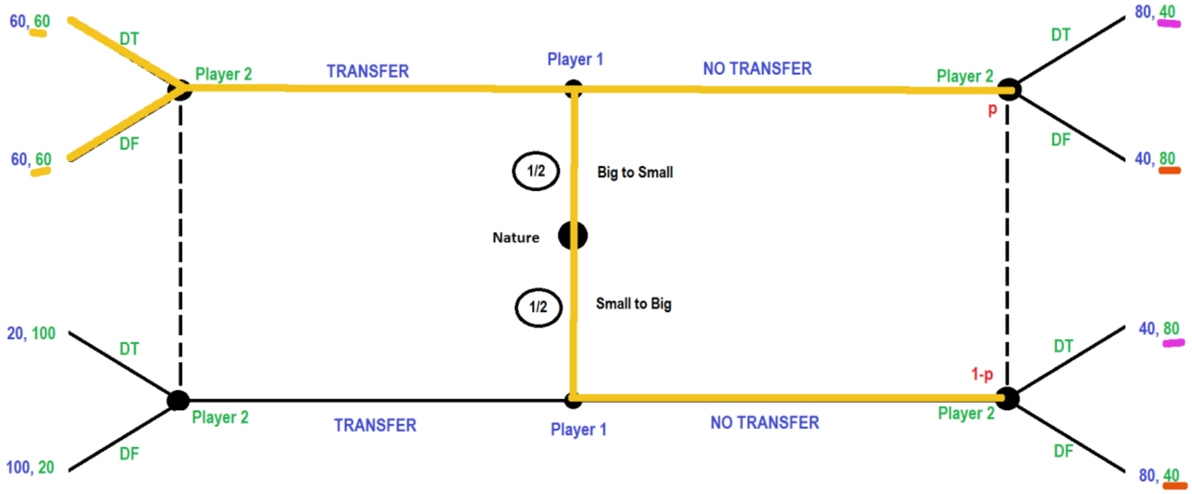
$$\frac{\frac{1}{2} \times 1}{\frac{1}{2} \times 1 + \frac{1}{2} \times prob_{notransfer|BS}}$$

$$\Leftrightarrow \frac{1}{2} \times (1 + prob_{notransfer|BS}) = 1 \Leftrightarrow prob_{notransfer|BS} = \frac{2}{1} - 1 = 1$$

Since Bayes' rule suggests that the probability of not transferring when P1 is of the BS-type equals one; we can conclude that there is no Semi-Separating PBNE in which P1 uses a mixed strategy as BS-type since this is contradicted. Bayes' rule suggests that P1 would deviate to a pure strategy of not transferring. Note that the same conclusion holds for transfer amount 35 since they both share a similar structure of strong dominance.

Next we look at the scenario of weak dominance. If a transfer is made P2 can deduce to be in the BS-transfer node; she would be indifferent between DT and DF since they both lead to a payoff of 60 tokens. For the Semi-Separating PBNE to exist we need to set P2's beliefs ('p') such that she becomes indifferent between DT and DF if no transfer is made (see Figure 45 and Equation 30).

Figure 45: Mixed Strategy if BS; No Transfer if SB: example transfer amount 20



Equation 30: P2s beliefs have to make her indifferent between DT and DF for the Semi-Separating PBNE to exist

$$EP_{P2}\left(DT \mid notransfer20\right) = 40p + 80(1-p) = 80 - 40p$$

$$EP_{P2}\left(DF \mid notransfer20\right) = 80p + 40(1-p) = 40 + 40p$$

P2 is indifferent between DT and DF if $80 - 40p = 40 + 40p \Leftrightarrow 40 = 80p \Leftrightarrow p = \frac{1}{2}$.

Next we compute the mixed strategy that P1 should use for this PBNE to exist; we use Bayes' rule (see Equation 31).

Equation 31: Using Bayes' Rule We Compute the Mixed Strategy for P1

$$\mathbf{P} = \frac{1}{2} = \frac{prob_{BS} \times prob_{notransfer|SB}}{prob_{BS} \times prob_{notransfer|BS} + prob_{SB} \times prob_{notransfer|SB}} =$$

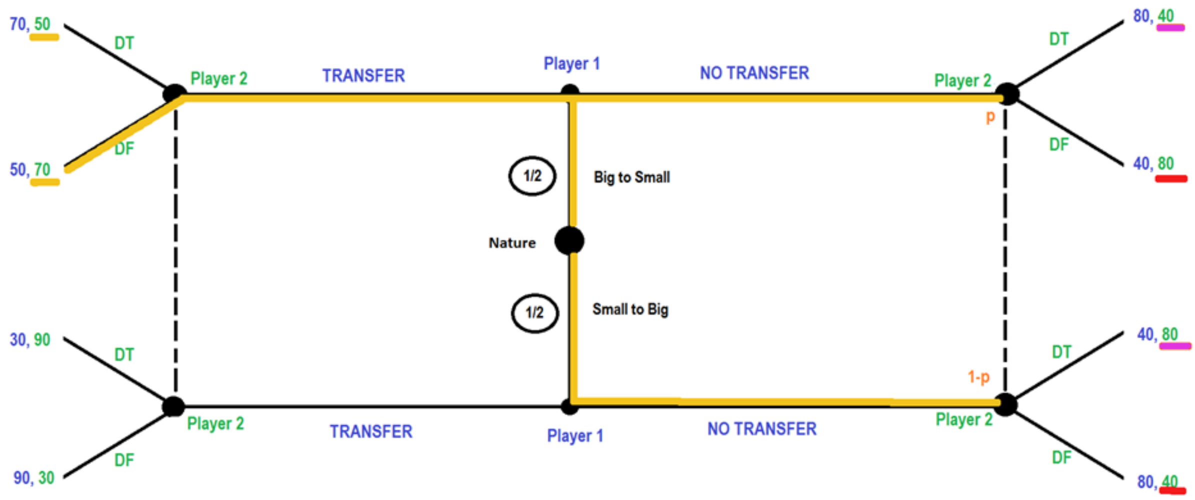
$$\frac{\frac{1}{2}\times 1}{\frac{1}{2}\times 1 + \frac{1}{2}\times prob_{notransfer|BS}}$$

$$\Leftrightarrow \frac{1}{2}\times(1 + prob_{notransfer|BS}) = 1 \Leftrightarrow prob_{notransfer|BS} = \frac{2}{1} - 1 = 1$$

Since Bayes' rule suggests that the probability of not transferring for the BS-type equals one; we can conclude that there is no Semi-Separating PBNE in which P1 uses a mixed strategy as BS-type since this is contradicted. Bayes' rule suggests that P1 would deviate to a pure strategy of not transferring.

Finally we look at scenarios without dominance using the example in which 10 tokens can be transferred (see Figure 46 and Equation 32).

Figure 46: Mixed Strategy if BS; No Transfer if SB: example transfer amount 10



Equation 32: P2s beliefs have to make her indifferent between DT and DF for the Semi-Separating PBNE to exist

$$EP_{P2}\left(DT \mid notransfer10\right) = 40p + 80(1-p) = 80 - 40p$$

$$EP_{P2}\left(DF \mid notransfer10\right) = 80p + 40(1-p) = 40 + 40p$$

P2 is indifferent between DT and DF if $80 - 40p = 40 + 40p \Leftrightarrow 40 = 80p \Leftrightarrow p = \frac{1}{2}$.

Next, we compute the mixed strategy that P1 should use for this PBNE to exist; we use Bayes' rule (see Equation 33)

Equation 33: Using Bayes' Rule We Compute the Mixed Strategy for P1

$$p = \frac{1}{2} = \frac{prob_{SB} \times prob_{notransfer|SB}}{prob_{BS} \times prob_{notransfer|BS} + prob_{SB} \times prob_{notransfer|SB}} =$$

$$\frac{\frac{1}{2} \times 1}{\frac{1}{2} \times 1 + \frac{1}{2} \times prob_{notransfer|BS}}$$

$$\Leftrightarrow \frac{1}{2}\times(1+prob_{notransfer|BS})=1 \Leftrightarrow prob_{notransfer|BS}=\frac{2}{1}-1=1$$

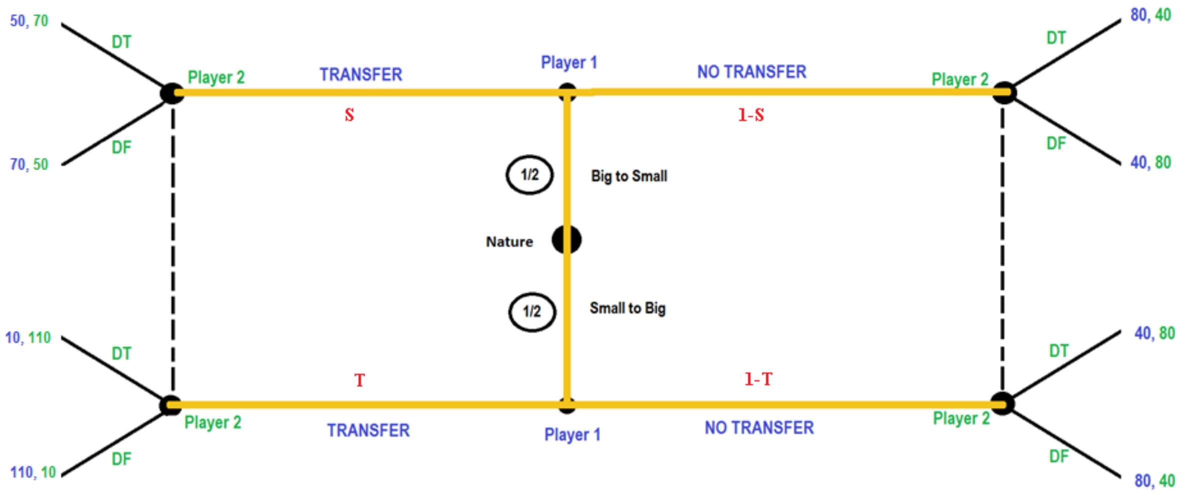
Since Bayes' rule suggests that the probability of not transferring when P1 is of the BS-type equals one; we can conclude that there is no Semi-Separating PBNE in which P1 uses a mixed strategy as BS-type since this is contradicted. Bayes' rule suggests that P1 would deviate to a pure strategy of not transferring. Again, the same holds true for the scenario in which 5 tokens can be transferred.

Fully Mixed PBNE

Fully Mixed PBNE's are those in which both the SB and BS-type use a mixed strategy. Using Bayes' rule we calculate parameter values for 'S' and 'T' (P2's beliefs) such that P2 becomes indifferent both if a transfer is made and if no transfer is made – if P2 is not indifferent in both scenarios then P1 would deviate with at least one of his types. If these parameter-values for 'transfer' and 'no transfer' scenarios contradict each other then there is no Fully Mixed PBNE possible.

First, we assess whether there is a Fully Mixed PBNE for scenarios of strong dominance using the example in which the transfer amount is 30 tokens (see Figure 47).

Figure 47: Is there a Fully Mixed PBNE for transfer amount 30 tokens



We use Bayes' rule to compute parameter values for S and T which need to be compatible both in case a transfer is made and in case the transfer is not made. Equation 34 computes the values for S and T if a transfer is made. Since we find impossible parameter values for the transfer scenario we do not need to assess the no transfer scenario.

Equation 34: if a transfer of 30 tokens is made

$$prob_{BS|transfer}\ \frac{prob_{BS} \times prob_{transfer|BS}}{prob_{BS} \times prob_{transfer|BS} + prob_{SB} \times prob_{transfer|SB}}$$

$$= \frac{\frac{1}{2} \times S}{\frac{1}{2} \times S + \frac{1}{2} \times T} = \frac{S}{S+T}$$

$$EP_{P2}\left(DT \mid transfer30\right) = 70\frac{S}{S+T} + 110\left(1 - \frac{S}{S+T}\right) = -40\frac{S}{S+T} + 110$$

$$EP_{P2}\left(DF \mid transfer30\right) = 50\frac{S}{S+T} + 10\left(1 - \frac{S}{S+T}\right) = 40\frac{S}{S+T} + 10$$

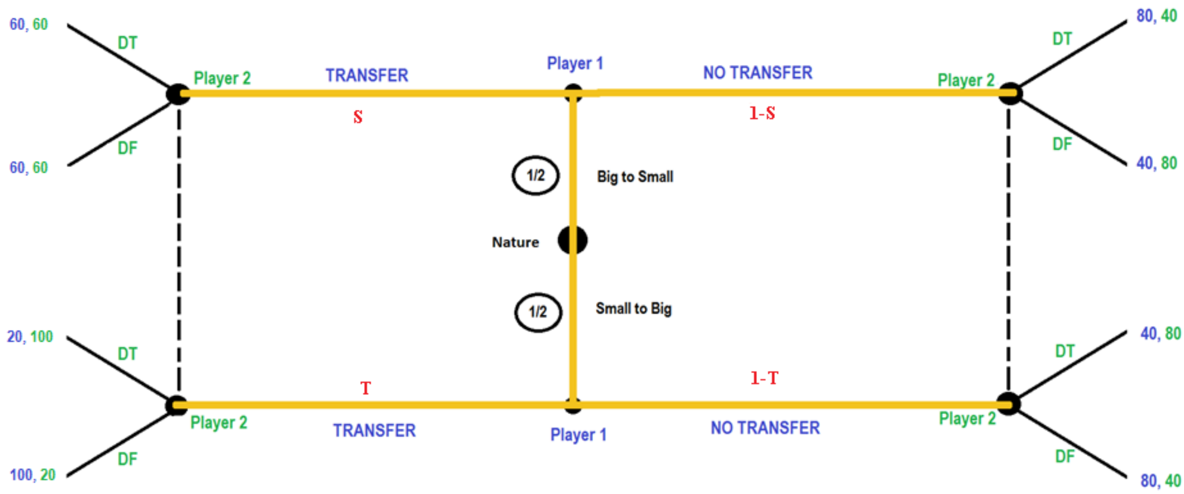
P2 is indifferent between DT and DF if $-40\frac{S}{S+T} + 110 = 40\frac{S}{S+T} + 10 \Leftrightarrow$

$$100 = 80\frac{S}{S+T} \Leftrightarrow 100S + 100T = 80S \Leftrightarrow 100T = -20S \Leftrightarrow T = -\frac{1}{5}S$$

Since ‘T’ is a probability it cannot be negative; furthermore, T and S cannot be zero or the structure of Fully Mixed equilibrium is lost. We conclude that there is no Fully Mixed PBNE involving the transfer amount of 30 tokens. Similarly, there is no such PBNE for the 35 token scenario.

Next, we assess whether there is a Fully Mixed PBNE when the transfer amount is 20 tokens following the same procedure (see Figure 48).

Figure 48: Is there a Fully Mixed PBNE for transfer amount 20 tokens



We use Bayes' rule again to compute parameter values for S and T which need to be compatible both in case a transfer is made and in case the transfer is not made.

Equation 35: If a transfer of 20 tokens is made

$$prob_{BS|transfer}\ \frac{prob_{BS}\times prob_{transfer|BS}}{prob_{BS}\times prob_{transfer|BS}+prob_{SB}\times prob_{transfer|SB}} =$$

$$= \frac{\frac{1}{2}\times S}{\frac{1}{2}\times S+\frac{1}{2}\times T} = \frac{S}{S+T}$$

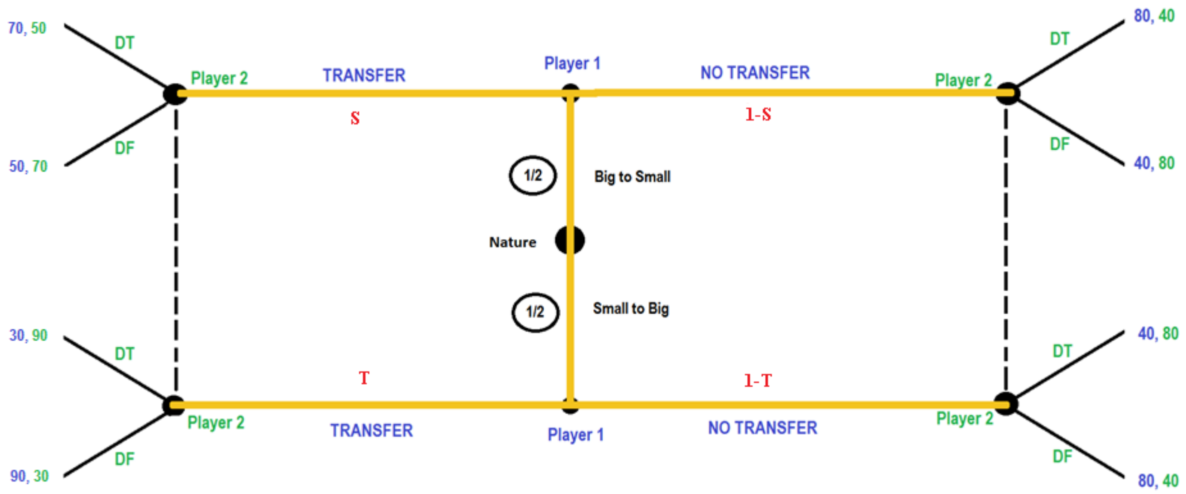
$$EP_{P2}\left(DT\,|\,transfer20\right) = 60\frac{S}{S+T}+100\left(1-\frac{S}{S+T}\right) = -40\frac{S}{S+T}+100$$

$$EP_{P2}\left(DF\,|\,transfer20\right) = 60\frac{S}{S+T}+20\left(1-\frac{S}{S+T}\right) = 40\frac{S}{S+T}+20$$

P2 is indifferent between DT and DF if $-40\frac{S}{S+T}+100 = 40\frac{S}{S+T}+20 \Leftrightarrow$ $80=80\frac{S}{S+T} \Leftrightarrow 80S+80T=80S \Leftrightarrow 80T=0 \Leftrightarrow T=0$. Since 'T' equals zero we cannot have a Fully Mixed PBE as the path "SB, transfer" would never occur. There is again no need to even explore the no transfer scenario.

Finally, we look at the scenario without dominance using the example in which 10 tokens can be transferred (see Figure 49).

Figure 49: Assessing whether there is a Fully Mixed PBNE for amount 10



We compute the parameter values for S and T in case the transfer is made (see Equation 36) and in case the transfer is not made (see Equation 37).

Equation 36: If a transfer of 10 tokens is made

$$prob_{BS|transfer} \frac{prob_{BS} \times prob_{transfer|BS}}{prob_{BS} \times prob_{transfer|BS} + prob_{SB} \times prob_{transfer|SB}} =$$

$$= \frac{\frac{1}{2} \times S}{\frac{1}{2} \times S + \frac{1}{2} \times T} = \frac{S}{S+T}$$

$$EP_{P2}\left(DT \mid transfer10\right) = 50\frac{S}{S+T} + 90\left(1 - \frac{S}{S+T}\right) = -40\frac{S}{S+T} + 90$$

$$EP_{P2}\left(DF \mid transfer10\right) = 70\frac{S}{S+T} + 30\left(1 - \frac{S}{S+T}\right) = 40\frac{S}{S+T} + 30$$

P2 is indifferent between DT and DF if $-40\frac{S}{S+T} + 90 = 40\frac{S}{S+T} + 30 \Leftrightarrow$

$$60 = 80\frac{S}{S+T} \Leftrightarrow 60S + 80T = 80S \Leftrightarrow 80T = 20S \Leftrightarrow T = \frac{1}{4}S$$

Equation 37: if no transfer of 10 tokens is made

$$prob_{BS|notransfer} \frac{prob_{BS} \times prob_{notransfer|BS}}{prob_{BS} \times prob_{notransfer|BS} + prob_{SB} \times prob_{notransfer|SB}} =$$

$$= \frac{\frac{1}{2} \times (1-S)}{\frac{1}{2} \times (1-S) + \frac{1}{2} \times (1-T)} = \frac{(1-S)}{(1-S)+(1-T)}$$

$$EP_{P2}\left(DT \mid notransfer10\right) = 40\frac{(1-S)}{(1-S)+(1-T)} + 80\left(1-\frac{(1-S)}{(1-S)+(1-T)}\right) =$$

$$-40\frac{(1-S)}{(1-S)+(1-T)} + 80$$

$$EP_{P2}\left(DF \mid notransfer10\right) = 80\frac{(1-S)}{(1-S)+(1-T)} + 40\left(1-\frac{(1-S)}{(1-S)+(1-T)}\right) =$$

$$40\frac{(1-S)}{(1-S)+(1-T)} + 40$$

P2 is indifference between DT and DF if $-40\frac{(1-S)}{(1-S)+(1-T)} + 80$ = $40\frac{(1-S)}{(1-S)+(1-T)} + 40 \Leftrightarrow 40 = 80\frac{(1-S)}{(1-S)+(1-T)}$

$$\Leftrightarrow 40\left(\left(1-S\right)+\left(1-T\right)\right) = 80\left(1-S\right) \Leftrightarrow 1\left(\left(1-S\right)+\left(1-T\right)\right) = 2\left(1-S\right)$$

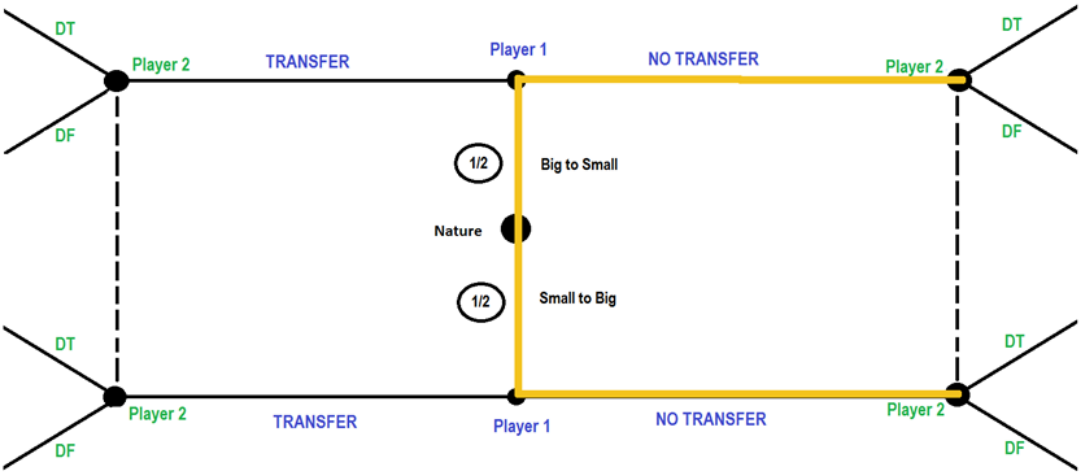
$$\Leftrightarrow \left(1-S\right)+\left(1-T\right) = 2-2S \Leftrightarrow 2-S-R = 2-2S \Leftrightarrow -S-T = -2S \Leftrightarrow T = S$$

For the Fully Mixed PBNE to exist we need to satisfy $T = \frac{1}{4}S$ and $T = S$. This cannot be done and hence there is no such PBNE. The same is true when the transfer amount is 5 tokens.

Nash conclusion

Each of the five transfer amounts has a Nash equilibrium state in which the Decider consistently decides not to transfer value (see Figure 50).

Figure 50: Equilibrium state in which the Decider never transfers value



Similar to the previous chapter the most obvious equilibrium state is one in which the Chooser consistently picks DT: this implies that the Decider does not want to transfer since any transfer he makes solely decreases his own expected payoff (i.e. DF decreases if transfers are made and the Chooser picks DT regardless whether the transfer is made). Furthermore, Choosers have no desire to change their strategy given that both boxes have the same EV when no transfer is made whilst DT has a higher EV when a transfer is made. However, the equilibrium state is maintained even when Choosers employ a mixed strategy with respect to certain probability thresholds. She should pick DT at least ‘Q’ percent of the time if no transfer is made to ensure that the Decider cannot gain from transferring if he were to transfer in BS-directionality, whilst she should pick DT at least ‘R’ percent of the time if a (hypothetical) transfer is made to ensure that the Decider cannot gain from transferring in SB-directionality[35] (see Table 22).

Table 22: Probability thresholds for Chooser behaviour under the Nash equilibrium

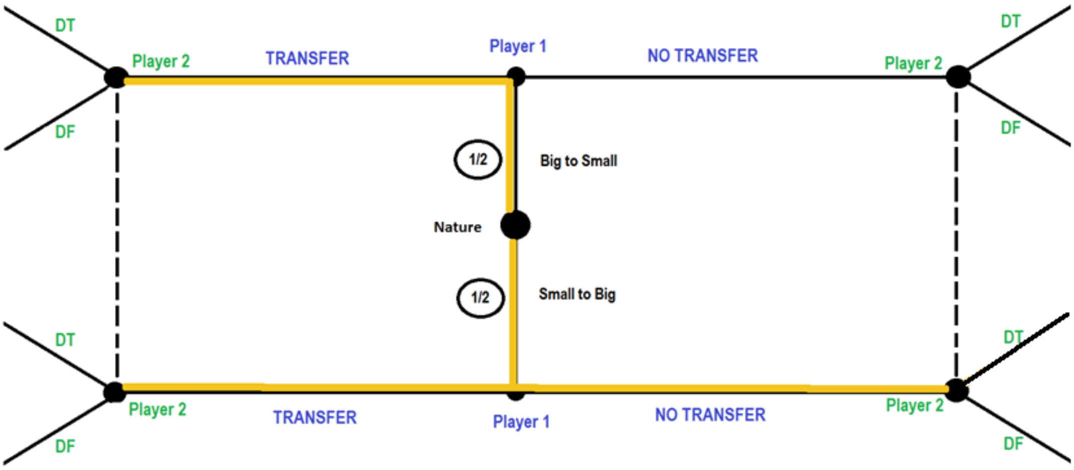
Transfer amount	prob(P2 picks DT | no transfer)	prob(P2 picks DT | transfer)
35	$Q \geq 0.125$	(strong dominance: no need to compute R)[36]
30	$Q \geq 0.25$	(strong dominance: no need to compute R)
20	$Q \geq 0.50$	$R \geq 0.75$
10	$Q \geq 0.75$	$R \geq 0.833$
5	$Q \geq 0.875$	$R \geq 0.90$

[35] Note that the values of the Q and R parameter depend upon the transfer amount.
[36] We can compute the R-parameter such that the Decider would not desire to transfer, however, due to strong dominance it will always be better for the Chooser to pick DT if a transfer is made (since DT must have a larger value than DF in these scenarios). Hence, a rational Chooser would not consider a DF choice if 30 or 35 tokens are transferred.

Using the numerical example in which the transfer amount is five tokens we have an equilibrium state in which the Decider never transfers value whilst the Chooser picks DT at least 87.5% of the time if no transfer is made whilst picking DT at least 90% of the time if a (hypothetical) transfer were made. The probabilities employed by the Chooser ensure that the Decider does not desire to transfer regardless the directionality of the suggested transfer.

A second equilibrium state exists solely for scenarios without dominance. This equilibrium allows the Decider to make a transfer when the directionality is BS whilst he uses a mixed strategy whenever the directionality is SB (see Figure 51).

Figure 51: Equilibrium state in which the Decider transfers in BS-directionality and mixes in SB-directionality



For this equilibrium to hold true we require knowledge on the probability in which the Decider makes the ‘no transfer’ decision in a SB-scenario. First we need to set the Chooser’s belief-parameter which reflects the probability assigned to being in the BS-node (contrasted with the SB-node) when a transfer is made. This parameter needs to be set such that Chooser’s EP of DT and DF are the same when a transfer is made as she would otherwise employ a ‘pure’ strategy (favouring DT or DF if a transfer is made) which would cause the Decider to change his strategy as well[37]. Secondly, we use Bayes’ rule to compute the probability in which the Decider should transfer in SB-directionality. These computations require the Chooser’s belief-parameter (i.e. the probability of being in the BS-node if a transfer is made), the known probabilities of being in the BS versus SB node (which is decided by

[37] Note that these computations in essence set parameter values such that the opposing player cannot gain from deviating from the equilibrium state that we explore.

nature as 50%) and the probability of the Decider making the transfer in BS-directionality (which is 100% for the suggested equilibrium structure). Together, these variables allow the computation of the Decider's mixed strategy in SB-directionality. Meanwhile, the Chooser's belief was set such that she is indifferent between DT and DF if a transfer is made; however, she still needs to select DT in a specific probability such that the Decider cannot gain from deviating from the suggested equilibrium structure. Concretely, we solve for the probability R in which the Chooser picks DT if a transfer is made such that the following equation holds: $EP_{P1}(\text{transfer}|SB) = EP_{P1}(\text{transfer}|BS)$.

Numerically we have an equilibrium state for the transfer amount of five tokens in which the Decider consistently transfers in BS-directionality whilst he transfers in SB-directionality in three out of five cases. The Chooser selects DT if no transfer is made (since this would only occur if the directionality is SB) whilst she picks DT with a probability of ninety percent if the transfer is made. We reach a stable state since neither player can increase their EP from changing their strategy. When the transfer amount is ten tokens the Decider again transfers consistently in BS-directionality but he would transfer in one out of three cases in SB-directionality. The Chooser again selects DT if no transfer is made (since it still occurs solely in SB-directionality) whilst she picks DT in five out of six cases when the transfer is made. A stable state is reached since neither player can gain from changing their strategy.

Level k predictions

In this section we discuss level k predictions for the Transfer Game. We use a simplified notation to denote the level of reasoning for the Decider as D_x whilst we denote the level of reasoning for the Chooser as C_x; the subscript 'x' refers to their level of reasoning. For example, D_0 refers to the Decider reasoning at level zero. Our main assumption is that each player considers themselves to reason exactly one level higher than their opponent and makes a best response on the assumed behaviour of the opponent. Thus, D_x makes his decisions on assumption that his opponent is C_{x-1} whilst C_x makes her decisions on assumption that her opponent is

D_{x-1}. We discuss level k predictions both under the assumption of risk neutrality and under the assumption of risk averseness; this is done separately for scenarios involving strong dominance, weak dominance and scenarios without dominance. We start with predictions for strong dominance under the assumption of risk neutrality.

In scenarios of strong dominance (i.e. when 30 or 35 tokens can be transferred) D_0 and C_0 are unsophisticated and make random decisions without considering the actions of the other player. At higher levels of reasoning decisions are based upon a best response strategy in relation to the expected actions of the opponent (who is assumed to be reasoning one level lower than themselves). D_1 beliefs that the unsophisticated C_0 is equally likely to prefer DT versus DF (regardless whether the transfer is made) thus D_1 decides randomly whether or not to transfer. Meanwhile, C_1's best response is to choose DT when the transfer is made since she realises dominance (i.e. DT is always better than DF when a transfer is made). When no transfer is made C_1 decides randomly since she expects D_0 to have decided randomly and hence either option can be better (same EVs). At level two D_2's best response is to 'never transfer'. C_2 behaves the same as C_1: if a transfer is made she picks DT else she picks randomly. At level three we assume the same behaviour by both parties since neither can make a 'better' best-response. Thus, a stable state is reached in which the Decider never transfers and in which the Chooser picks DT if a transfer is made whilst she picks randomly if no transfer is made (see Table 23).

Table 23: Level k predictions under strong dominance (i.e. transfer amount 30 and 35)

	Decider		Chooser	
	Info: Directionality		Info: Choice made by P1	
	BS	SB	Make Transfer	Do Not Transfer
Level 0	Random	Random	Random	Random
Level 1	Random	Random	DT	Random
Level 2	No Transfer	No Transfer	DT	Random
Level 3	No Transfer	No Transfer	DT	Random

Next, we assess the scenario in which weak dominance is involved (i.e. when 20 tokens can be transferred). D_0 and C_0 are again unsophisticated and make random decisions without considering the actions of the other player. D_1 expects C_0 to decide randomly. Since D_1 beliefs that the unsophisticated C_0 is equally likely to prefer DT versus DF he decides randomly whether or not to transfer (both for BS and SB-directionality). Meanwhile, C_1's best response is to choose DT whenever a transfer is made since she realises the weak dominance (i.e. DT cannot be worse than DF when a transfer is made). When no transfer is made C_1 decides randomly since she expects D_0 to have decided randomly not to transfer and hence either option may be better (same EVs). Next, we discuss level two reasoning. D_2's best response to C_1 is not to transfer in a SB-directionality whilst he decides randomly in a BS-directionality. C_2 acts the same as C_1: if a transfer is made she picks DT due to weak dominance whilst she picks randomly if no transfer is made. We now assess level three reasoning. D_3 acts the same as D_2: he does not transfer in SB-directionality whilst he decides randomly in BS-directionality. C_3 now realises that transfers are solely made in BS-directionality whilst no transfers are made in BS or SB-directionality. She picks DT whenever a transfer is made (weak dominance); and she also picks DT when no transfer is made since it is more likely to be the result of a SB-directionality than of a BS-directionality (i.e. the BS-type can decide to transfer whilst the SB-type cannot whilst both types are expected to have the same base frequency). Next, we discuss level four. D_4 realises that C_3 always picks DT; thus, he does not transfer as BS-type (i.e. he does not want to make DF smaller since he expects to receive DF regardless his decision) and he does not transfer as SB-type either (i.e. he again expects to receive DF regardless his decision and thus he does not want to make DF any smaller). C_4 consistently picks DT just like C_3 did. Regarding higher level reasoning, we point out that neither player can do a better best-response on their opponent's expected behaviour and thus a stable state is reached[38] (see Table 24).

Table 24: Level k predictions under weak dominance (i.e. transfer amount 20)

	Decider		Chooser	
	Info: Directionality		Info: Choice made by P1	
	BS	SB	Make Transfer	Do Not Transfer
Level 0	Random	Random	Random	Random

[38] The reader may wonder why the level-five Chooser does not make random choice if no transfer is made given that it is the best response versus a level four Decider. The reasoning is that the behaviour from level four Choosers is equally good and thus she has no reason to change her strategy (both are a best response; whilst the one from level four was already successful at lower level so why should she change her strategy if she cannot gain from it).

Level 1	Random	Random	DT	Random
Level 2	Random	No Transfer	DT	Random
Level 3	Random	No Transfer	DT	DT
Level 4	No Transfer	No Transfer	DT	DT
Level 5	No Transfer	No Transfer	DT	DT

Finally, we assess level k reasoning for scenarios without dominance (i.e. 5 and 10 token transfers). D_0 and C_0 remain unsophisticated and make random decisions without considering the actions of the other player. D_1 expects C_0 to decide randomly. Since D_1 beliefs that the unsophisticated C_0 is equally likely to prefer DT versus DF he decides randomly whether or not to transfer (both for BS and SB-directionality). Meanwhile, C_1's best response is to choose DT whenever a transfer is made since $EV(DT|transfer) > EV(DF|transfer)$. When the transfer is not made C_1 chooses randomly since she expects D_0 to have decided randomly not to transfer and hence either option may be better (same EVs). Next, we discuss level two reasoning. D_2's best response to C_1 is to transfer in BS-directionality and not to transfer in SB-directionality. When we look at the Chooser we see that C_2 behaves the same as C_1: she picks DT if a transfer is made and she picks randomly if no transfer is made. Next, we discuss level-three behaviour. D_3 behaves the same as D_2: he transfers in BS-directionality but does not transfer in SB-directionality. Meanwhile, C_3 realises that D_2 attempts to outsmart her; thus, she deduces the directionality based on D_2's behaviour. Her best response is thus to pick DF if a transfer is made whilst picking DT if no transfer is made. From level four onwards Deciders and Choosers start reversing their strategies in continuous attempts to outsmart their opponent. D_4 now makes the transfer when the directionality is SB whilst he does not transfer when the directionality is BS. C_4 behaves the same as C_3. At the next level the Chooser realises that the opponent tries to outsmart her and hence she reverses tactics, one level higher the Decider realises that she reversed tactics and hence he reverses tactics etc. (see Table 25).

Table 25: Level k predictions without dominance (i.e. amounts 5 and 10)

	Decider		Chooser	
	BS	SB	Transfer	No Transfer
Level 0	Random	Random	Random	Random
Level 1	Random	Random	DT	Random

Level 2	Transfer	No Transfer	DT	Random
Level 3	Transfer	No Transfer	DF	DT
Level 4	No Transfer	Transfer	DF	DT

Next, we discuss level k predictions under the assumption of risk averseness. Both the literature and the risk attitude measurement from our previous chapter suggest that participants in experimental games generally behave in risk averse fashion. Hence, it is worthwhile to explore how level k behaviour changes if we make such an assumption. The main difference for risk averse predictions is that D_0 attempts to decrease the value difference between the two boxes. We again start by discussing the predictions for strong dominance, followed by weak dominance followed by no dominance.

In scenarios of strong dominance (i.e. when 30 or 35 tokens can be transferred) the unsophisticated D_0 player aims to decrease the value difference between the two boxes by making the transfer in BS-directionality but not in SB-directionality. Meanwhile, the unsophisticated C_0 player is assumed to decide randomly without regards to her opponents actions. At higher levels of reasoning decisions are based solely upon a best response strategy in relation to the expected actions of the opponent (who is assumed to be reasoning one level lower than themselves). Thus, when we explore level one reasoning D_1 aims to make a best response to the behaviour of C_0. Since C_0 is assumed to behave randomly without consideration of the Decider's strategy D_1 employs the same strategy as he used at level zero: he makes the transfer in BS-directionality and he does not transfer in SB-directionality. Meanwhile, C_1 makes a best response on D_0's behaviour by picking DT both when the transfer is made and when the transfer is not made. We now reach level two. D_2 is aware that C_1 picks DT regardless his choice. Thus, his best response is to never transfer since it provides him with a better payoff regardless the directionality. Meanwhile, C_2 behaves the same as C_1: she always picks DT. We next reach level three. D_3 behaves the same as D_2: he never makes the transfer. Meanwhile, C_3 cannot make a better 'best response' than repeating her actions from the previous level and thus we have reached a stable state: the Decider never makes a transfer whilst the Chooser picks DT consistently (see Table 26).

Table 26: Risk averse level k predictions under strong dominance (i.e. transfer amount 30 or 35)

	Decider		Chooser	
	BS	SB	Transfer	No Transfer
Level 0	Transfer	No transfer	Random	Random
Level 1	Transfer	No transfer	DT	DT
Level 2	No transfer	No transfer	DT	DT
Level 3	No transfer	No transfer	DT	DT

In scenarios of weak dominance (i.e. when 20 tokens can be transferred) the unsophisticated D_0 player aims to decrease the value difference between the two boxes by making the transfer is BS-directionality whilst not making the transfer in SB-directionality. Meanwhile, the unsophisticated C_0 player is assumed to decide randomly without regards to her opponents actions. At higher levels of reasoning decisions are based upon a best response strategy in relation to the expected actions of the opponent (who is assumed to be reasoning one level lower than themselves) and on their risk averse attitude. D_1 behaves the same as D_0 since he expects the C_0-opponent to behave randomly. Meanwhile C_1 realises that D_0 only makes the transfer for BS-directionality. When the transfer is made C_1 picks DT (since it cannot be worse than DF). When the transfer is not made she picks DT (since her opponent would only refuse to transfer in SB-directionality). Next, we reach level two. D_2 knows that his opponent picks DT regardless whether he transfers. Thus, he does not transfer in BS-directionality (since it would decrease his expected payoff) nor does he transfer in SB-directionality (since it would decrease his expected payoff). Neither player can make a better ‘best response’ and thus we reached a stable state (see Table 27).

Table 27: Risk averse level k predictions under weak dominance (i.e. transfer amount 20)

	Decider		Chooser	
	BS	SB	Transfer	No Transfer
Level 0	Transfer	No transfer	Random	Random
Level 1	Transfer	No transfer	DT	DT
Level 2	No transfer	No transfer	DT	DT
Level 3	No transfer	No transfer	DT	DT

In scenarios without dominance (i.e. when 5 or 10 tokens can be transferred) the unsophisticated D_0 player aims to decrease the value difference between the two boxes by making the transfer is BS-directionality whilst not making the transfer in SB-directionality. Meanwhile, the unsophisticated C_0 player is assumed to decide randomly without regards to her opponents actions. At higher levels of reasoning decisions are based upon a best response strategy in relation to the expected actions of the opponent (who is assumed to be reasoning one level lower than themselves). D_1 behave the same as D_0 since he expects the C_0-opponent to behave randomly. Meanwhile C_1 realises that D_0 only makes the transfer for BS-directionality and thus she can deduce directionality from her opponent's behaviour. When the transfer is made C_1 picks DF and when the transfer is not made she picks DT. Next, we discuss level-two. D_2 knows that C_1 decides conditional on his own transfer decision. Thus, he attempts to exploit her behaviour by making the transfer when the directionality is SB whilst not transferring in BS-directionality. C_2 behaves the same as C_1. Next, we reach level three. D_3 behaves the same as D_2; meanwhile, C_3 has realised that D_2 exploits her decision rule and thus she reverses her strategy. C_3 now chooses DT when the transfer is made whilst she picks DF when the transfer is not made. It should be clear at this point that behaviour between the two players keeps on reversing itself at higher levels in a continuous attempt to outsmart the opponent.

Table 28: Risk averse level k predictions without dominance (i.e. transfer amount 5 or 10)

	Decider		Chooser	
	BS	SB	Transfer	No Transfer
Level 0	Transfer	No transfer	Random	Random
Level 1	Transfer	No transfer	DF	DT
Level 2	No transfer	Transfer	DF	DT
Level 3	No transfer	Transfer	DT	DF
Level 4	Transfer	No transfer	DT	DF

Maximin principle

The maximin principle is the paradigmatic risk averse strategy and ensures that the player receives the best out of all worst-case-scenario outcomes. Concretely, the participant assesses the worst possible outcome for each decision he can make; and he selects the decision whose worst outcome is superior to the worst outcome of alternative decisions (Colman, 1982). It is of particular interest to explore the maximin predictions for the Transfer Game experiment since the transfer amount is predefined by the computer (in contrast to the Envelope Game – and the later Suitcase Game – in which P1 decides upon the transfer amount himself). As a result choice options are often suboptimal to express the participant's exact preferences.

The maximin-behaving participant desires to transfer twenty tokens from the box with eighty tokens to the box with forty tokens such that his minimum pay-off is maximized (since sixty tokens is that maximum amount that can be ensured as a minimum pay-off in our setup). However, Deciders face decisions in which they have no control over the transfer amount nor the directionality of the transfer. For maximin-behaving Deciders we expect that (regardless the transfer amount) transfers are made when the directionality is BS whilst transfers are not made in SB-directionality. As example, consider the scenario in which five tokens can be transferred. When the transfer is in SB-directionality the Decider earns at minimum forty tokens from not transferring whilst he earns at minimum thirty-five tokens from transferring. Using a minimax strategy he thus desires to not transfer since forty tokens offer a larger minimum value than thirty-five tokens. When the directionality is BS (big to small) the maximin-behaving Decider makes the transfer regardless the transfer amount since the minimum pay-off of transferring is always higher than the minimum pay-off of not transferring. For example, if five tokens can be transferred in BS-directionality the Decider earns at minimum forty tokens from not transferring whilst he earns at minimum forty-five tokens from transferring. Using a maximin strategy he thus desires to transfer since forty-five tokens offers him a larger minimum value than forty tokens. It is worthwhile to point out that when Deciders use a maximin strategy in scenarios of strong dominance (i.e. when the transfer amount is 30 or 35 tokens) they would make the transfer even though this means that the Chooser has a strongly dominance choice available and will end up with the larger box. The maximin strategy ensures that the Decider ends up with a smaller pay-off than the Chooser by avoiding the risk of a lower minimum pay-off.

For Choosers maximin predictions are to pick DT whenever a transfer is made since DT is known to contain at least forty tokens (both boxes are known to contain at minimum forty tokens initially) plus the transfer amount whilst DF may contain forty tokens minus the transfer amount. If no transfer is made then the maximin prediction would be to pick randomly since both boxes have the same minimum value.

Experimental setup

Participants

Participants for Experiment Two were 24 students and employees from Warwick University, with an average age of 21 years old. Our overall sample (across Experiment Two and Experiment Three) was predominantly female (27 female, 16 male)[39]. Recruitment was done through SONA, an online system for participant recruitment. We ran two experimental sessions each consisted of exactly twelve participants. The experiment is meant as a 'proof of concept' exploration for our experimental game which is why we kept the sample size relatively small. To avoid cancelling sessions due to participants not showing up we recruited four additional participants per session; if more than twelve participants showed up before the starting time we randomly selected participants to be send home with a £2 show-up fee. The possibility of being send home (due to an exact number of participants being required for the study) was advertised on SONA when participants signed up. Excluding participants happened through a procedure of shuffling a deck of cards (containing the cubicle numbers of all occupied computers) and randomly drawing one or more cards.

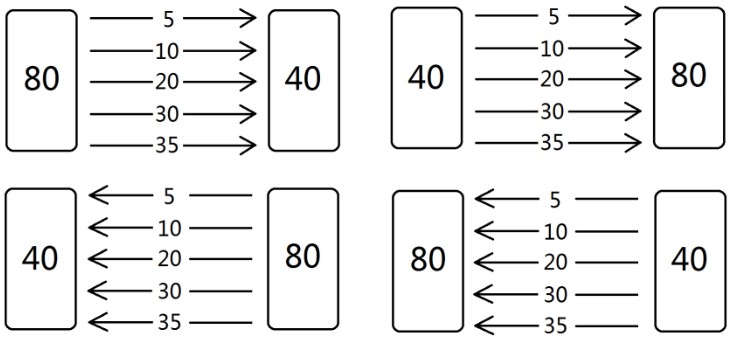
Participants were paid a show-up fee (£2) and an additional performance fee (£0.50-£11.50) based on a random lottery incentive system. The expected pay-off for the average participant is £8; and the average participant earned £8.10. Participants are told during an introductory PowerPoint explanation that they earn a performance fee based on the amount of tokens won in a randomly selected trial. We did not inform participant of the conversion rate (tokens to pounds) to avoid potential biases due to monetary expectations. Each token that is won in the randomly selected trial translated into an additional £0.10 in performance fee. We did not provide participants with details regarding the random selection procedure for the 'performance fee' trial; concretely, a python script randomly selects a trial per participant to base their performance fee on. Different participants can be remunerated upon performance in different trials.

[39] Note that demographics data from Experiment Two and Experiment Three was pooled together on SONA since we advertised both experiments using the same sign-up screen. Furthermore, we have missing information on the demographics of part of the sample due to yearly SONA-maintenance deleting demographics data from its server.

Materials

The experiment was performed in the Behavioural Science Lab; the coding was done by the author using a combination of python, HTML/CSS and willow. Participants faced a total of forty trials; and they swapped between being in the role of P1 and being in the role of P2 on each consecutive trial (to maximize fairness and exposure to both roles). They were randomly re-matched on every trial with an anonymous opponent and were aware of this. Random re-matching was programmed to be fully random; in theory participants can be matched twice in a row with the same opponent but they do not know who they play against. The twenty trials played as P1 (Decider) are summarized in Figure 52; the same twenty trials are also played as P2 (but without the knowledge which of these trials is being played).

Figure 52: Summary of possible scenarios

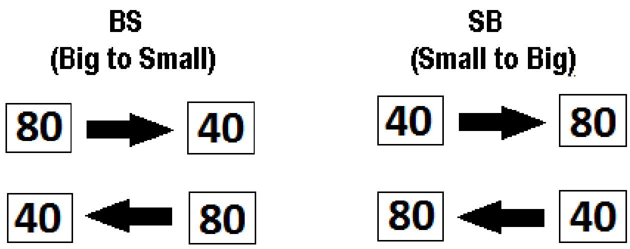


This figure provides a schematic overview of the twenty trials that are played in either role.

Decider trials involve three variables. Firstly, the transfer amount is one of five values (i.e. five, ten, twenty, thirty or thirty-five tokens). Transfer amounts for the experiment were chosen such that we have trials representing scenarios without dominance (i.e. 5 and 10), scenarios with weak dominance (i.e. 20) and scenarios with strong dominance (i.e. 30 and 35).

Secondly, the larger value is physically displayed on the left versus right side of the screen; this variable is included to account for potential biases due to physical preferences. Thirdly, the transfer direction is physically either from left to right or from right to left. Taken together the physical screen location and physical transfer direction allow us to explore both scenarios in which a transfer would increase the variance between the two boxes and scenarios in which a transfer would decrease their variance. In Appendix 2.1 we show that the physical screen location of the larger amount does not affect behaviour and thus we collapsed these two variables (i.e. ‘physical screen location’ and ‘physical transfer direction’) into a new variable called ‘directionality’. As was mentioned in earlier sections directionality is coded as BS (i.e. Big to Small) when the suggested transfer is from the box with 80 tokens to the box with 40 tokens; or SB (i.e. Small to Big) when the suggested transfer is from the box with 40 tokens to the box with 80 tokens (see Figure 53).

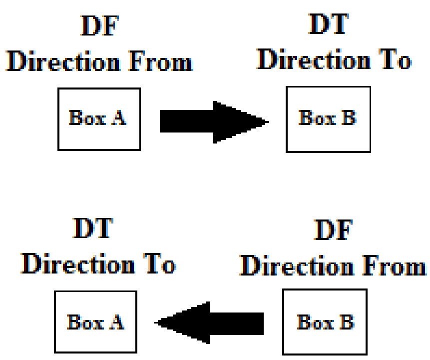
Figure 53: Collapsing Screen Location and Direction into the Directionality Variable



This figure illustrates how screen location and direction are collapsed into a ‘directionality’ variable which is either BS or SB.

It is worthwhile to point out that the Chooser does not know whether the 80 tokens are in the left versus right box (i.e. physical screen location) and thus she cannot assess whether the directionality is BS versus SB. We code decisions made by Choosers based on whether she picks the box where the tokens can be transferred from (i.e. Direction From; DF) versus the box where tokens can be added to (i.e. Direction To; DT) (see Figure 54).

Figure 54: Explaining the Coding for Player Two's Decisions



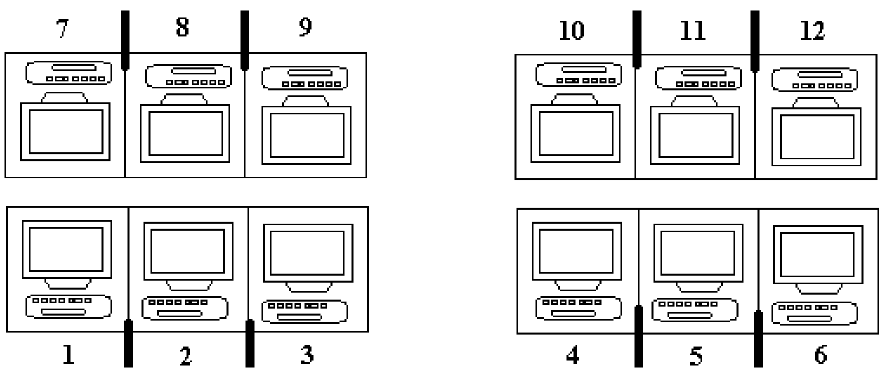
This figure illustrates how we code Chooser decisions as DF versus DT based on the direction of the suggested transfer and the box-selection.

Finally, it is worthwhile to point out that we subdivided each experimental session into two mini-sessions. Concretely, sessions consist of twelve participants; six of them are placed in 'Mini-Session A' whilst the other six are placed in 'Mini-Session B'. Participants can only be matched with others from the same mini-session. We did not inform participants that they are in one of two mini-sessions as this would affect their perspective on potential opponents to be (re-)matched with. The logic behind these independent mini-sessions is to maintain the same prior experience for participants who are matched together whilst decreasing the risk of biases due to sequence effects (i.e. we now use twice as many randomly generated trial orders). Every trial participants are randomly re-matched and they do not know who they are matched with. We did not drop variables, conditions or trials from our analysis.

Procedure

The experiment consisted of two experimental sessions each consisting of exactly 12 participants (N=24). A 75-minute timeframe was available for each session and sessions typically lasted 60 minutes. Using an alphabetical listing of signed-up participants we allocated everyone to numbered cubicles. The experiment is set-up such that adjacently seated participants have the same starting role; though they are unaware of this feature (see Figure 55).

Figure 55: Experimental Setup



This figure provides a schematic overview of our experimental layout. Participants sit in two rows of desks each with a computer. Shutters (partitions) are used such that they can only see their own computer. Participants in the same row (e.g. 1-6) start the experiment in the same role.

If more than twelve people showed up we would randomly exclude participants by blindly selecting a cubicle number from a pack of numbered cards after shuffling the cards in front of the participants. Excluded participants received a £2 show-up fee and filled in a payment receipt after which the doors were closed and the experimental setup was explained by means of a PowerPoint presentation (see Appendix 2.2 for details on instructions). The main points from the PowerPoint instructions are shortly summarized below:

> Each trial you see two boxes on the screen. We refer to the left box as Box A and we refer to the right box as Box B. You are informed that one of the boxes contains 40 tokens whilst the other box contains 80 tokens -- but you do not know which box has which token amount. You are either assigned the role of Decider (player one) or the role of Chooser (player two). As Decider you can look at the true content of the two boxes and you are presented with a transfer suggestion. The computer suggests a transfer of a predefined token amount in a predefined direction and informs the Decider how many tokens would be in either box if the suggested transfer is made. You decide whether or not to make the suggested transfer by clicking on the corresponding button. Next, the Chooser has to make a decision. She does not know which box contains which token amount but she knows the transfer suggestion and whether or not this suggested transfer was made. Her task is to decide which of these two boxes she wants to have for herself (which decides her own payoff) by clicking the button underneath the desired option. The unchosen option is assigned to the Decider (deciding his payoff). Feedback is provided after every trial specifying which box you received and what its final contents are; furthermore, feedback also informs you of the box received by the other player and its content. After each trial your role swaps (i.e. Deciders become Choosers and Choosers become Deciders) and you are randomly re-matched with another player for the next trial. A total of forty trials is played for the experiment. Regarding your final payment you receive a participation fee of £2 and additionally you earn a performance fee based on the amount of tokens you win in a randomly selected trial.

Participants were given the opportunity to raise their hand if further clarification was required and were informed that they could do so at any time during the experiment if they had further questions. Before starting the experiment participants were asked to put their electronic devices and notes away. Furthermore, between each experimental cubicle we pulled out ‘shutters’ (i.e. partitions) to avoid the temptation of glancing on a neighbour’s computer screen. At the end of the experiment pay-offs were calculated using a python script. Concretely, the script randomly generates a trial number for each participant and assesses how many tokens they won on that particular trial. Tokens are multiplied by a factor of 0.1 to generate the performance fee and a two pounds show-up fee is added in. The python script does this for every participant and makes a clean output file with a summary of cubicle numbers and payments.

Finally, participants fill in receipts for payment and are asked to come forward when we call their cubicle number to receive payment in exchange for their receipt ticket. Data from the experiment is stored in a time-stamped folder containing a multitude of CSV-files (i.e. one for each trial played by each participant ─ if the program were to malfunction not all data would be lost) and these are converted into a big CSV-datafile using a python script. The data is analysed using RStudio.

Objectives

Our main objectives for this study are to assess behaviour in a novel experiment. We explore how well theories and models (henceforth referred to as 'frameworks') predict behaviour. Additionally we collect data on reasoning in Experiment Three to assess how the task is approached and to which degree different frameworks explain behaviour. Furthermore, we assess whether adherence to frameworks is consistent across trials. This chapter has the following structure. First we discuss Experiment Two and categorize predictions of the frameworks which we discussed earlier into different 'decision profiles'. We assess the degree in which behaviour aligns with these profiles (in contexts where the profile is applicable). Furthermore, we compare whether participants who behave according to a decision profile in their trials of a specific dominance level (e.g. strong dominance) also behave according to a (same or other) decision profile on trials involving a different dominance level. This is done separately for Deciders and Choosers. Next, we introduce Experiment Three and discuss the main differences in its setup compared with Experiment Two. The main idea of Experiment Three is to reach a better insight into reasoning processes to help explain behaviour. We discuss behaviour of Deciders and Choosers sequentially starting with scenarios of strong dominance and ending with scenarios without dominance. This section contains a summary of frequencies in which 'teams' reasoned in specific ways with quotations to provide the reader with an adequate understanding of how participants approached their tasks. We conclude the section on Experiment Three with a discussion on consistency of behaving according to specific frameworks across roles based on the reasoning data collected and an assessment on whether dominance awareness persists across consecutive trials. Finally, we discuss relationships between behaviour in Experiment Two and reasoning data from Experiment Three.

Results

Experiment Two

Decider behaviour

In this section we first provide the reader with an overview of the predictions that were made by the theoretical models and frameworks discussed earlier and we provide an overview table with observed behaviour[40]. We discuss our predictions separately for scenarios of strong dominance, weak dominance and without dominance to simplify the discussion. We remind the reader that subscripts indicate risk attitudes (see Table 29, Table 30, and Table 31).

Table 29: Strategy profiles for Deciders in scenarios of strong dominance

	Strategy	Frameworks
Profile 1	Never transfer	Nash_A, Nash_N, $\mathrm{Level2}_A$, $\mathrm{Level2}_N$
Profile 2	BS: transfer SB: no transfer	Maximin, $\mathrm{Level1}_A$

Table 30: Strategy profiles for Deciders in scenarios of weak dominance

	Strategy	Frameworks
Profile 1	Never transfer	Nash_A, Nash_N, $\mathrm{Level2}_A$, $\mathrm{Level4}_N$
Profile 2	BS: transfer SB: no transfer	Maximin, $\mathrm{Level1}_A$
Profile 3	BS: random SB: no transfer	$\mathrm{Level2}_N$

Table 31: Strategy profiles for Deciders in scenarios without dominance

	Strategy	Frameworks
Profile 1	Never transfer	Nash_A, Nash_N
Profile 2	BS: transfer SB: no transfer	Maximin, $\mathrm{Level2}_N$, $\mathrm{Level1}_A$
Profile 4	BS: no transfer SB: transfer	$\mathrm{Level4}_N$, $\mathrm{Level3}_A$

[40] Note that we do not assess the more complex 'mixed strategies' that are suggested by Nash. This is true for P1 and P2 across our three chapters – it is hard to assess mixed strategies with our limited data; and additionally the literature suggests that human decision makers rarely use mixed strategies and only do so in special types of scenarios.

We calculated the frequency in which Deciders transfer versus do not transfer in each scenario. Each row has two observations per Decider under BS and two observations under SB (see Table 32).

Table 32: Observed behaviour for Deciders

Transfer Amount	BS		SB	
	Transfer	No transfer	Transfer	No transfer
35	20	28	15	33
30	26	22	15	33
20	34	14	16	32
10	36	12	25	23
5	28	20	26	22

In BS-scenarios of strong dominance the Decider makes transfer and no transfer decisions in roughly the same frequencies and one third of the sample still makes the transfer in SB-scenarios. For BS-scenarios it is plausible that half the sample adheres to the first strategy profile whilst the other half of the sample adheres to the second profile; however, neither profile would predict that one third of the participants makes a transfer in SB-scenarios of strong dominance. This is extremely unexpected[41]. For scenarios of weak dominance we see the same odd transfer frequency in SB-directionality with one third of the sample making such transfers whilst we see a boost in transfer frequency in BS-directionality. This boost may potentially be due to a larger part of the sample behaving according to the second profile. For scenarios without dominance we observe a similar high preference for transferring in BS-directionality when the amount is ten tokens whilst the frequency of transferring five tokens is slightly lower. It is interesting that the five token scenario hasn't got the same boost in transfer frequency for BS-scenarios compared to the ten and twenty token amount; our section on verbal protocols will shed some light on this. Finally, when we look at scenarios without dominance involving the SB-directionality we conclude that the transfer and no transfer frequencies look roughly the same.

Next, we separate data on individual participants to assess whether certain strategy profiles are consistently used by particular Deciders. Since we only have two observations per Decider in BS and in SB scenarios for each transfer amount we merge scenarios depending on their dominance level (i.e. transfer amount 30 and 35

[41] Given our small sample it is worthwhile to consider a future replication study with a larger sample to assess whether the finding is consistent.

are taken together; and transfer amount 5 and 10 are taken together). Tables with data per dominance level are found in Appendix 2.3; but a summary table across dominance levels is provided in Table 33.

Table 33: Decider profiles at each level of dominance

	Strong dominance	Weak dominance	No dominance
0	NA	NA	NA
1	NA	NA	NA
2	NA	NA	Profile 4
3	Profile 2	NA	NA
4	Profile 1	NA	NA
5	NA	Profile 2	Profile 1
6	NA	Profile 2	Profile 2
7	Profile 2	Profile 3	NA
8	NA	Profile 2	NA
9	Profile 2	NA	NA
10	NA	NA	NA
11	Profile 1	Profile 3	NA
12	NA	Profile 3	NA
13	Profile 2	NA	Profile 2
14	NA	Profile 1	Profile 2
15	Profile 1	Profile 2	Profile 2
16	NA	Profile 3	NA
17	NA	NA	Profile 2
18	Profile 2	NA	Profile 2
19	Profile 1	Profile 2	Profile 2
20	NA	NA	NA
21	NA	Profile 1	NA
22	NA	Profile 3	NA
23	Profile 1	NA	NA

Note that our coding into profiles allows for a slight ‘trembling hand’ for scenarios of strong dominance and scenarios without dominance but that this is not possible for scenarios of weak dominance due to its lower number of observations per participant (i.e. the only scenario of weak dominance that we can assess involves twenty tokens). We categorize five subjects as profile one (purple colours) and five subjects as profile two (i.e. green colours) in scenarios of strong dominance. This means that 60% of participants do not behave according to the strategy profiles suggested by theories in context of strong dominance. For scenarios of weak dominance we categorize two participants as profile 1 (i.e. purple colours); five participants as profile 2 (i.e. green colours) and five participants as profile three (i.e. orange colours). 50% of the sample does not behave according to predictions from the frameworks. For scenarios without dominance we observe one participant for profile 1 (i.e. purple colours), seven participants for profile 2 (i.e. green colours), and one participant for profile 4 (i.e. red colours). This means that 63% of participants do not behave according to the suggested profiles for scenarios without dominance.

Furthermore, our summary table suggests that participant's choice profiles are not consistent across dominance levels. It is worth pointing out that profiles are based upon the actions that the Decider would take according to specific frameworks and that the level k framework suggests different actions according to the dominance. However, even when we take these relationships into account choice profiles for individual subjects remain inconsistent across the dominance levels. In the next section we look at aggregate data for each of the three dominance levels and assess whether there are any special relationships depending on the directionality of the suggested transfer.

Strong dominance

We first discuss Decider-behaviour in scenarios where 30 or 35 tokens can be transferred. Behaviour can be categorized by counting how frequently the Decider makes the transfer out of his four BS-decisions and his four SB-decisions (see Table 34).

Table 34: Decider behaviour in presence of strong dominance

	BS	SB
Transfer/No Transfer: 4/0	4	0
Transfer/No Transfer: 3/1	3	5
Transfer/No Transfer: 2/2	8	3
Transfer/No Transfer: 1/3	5	9
Transfer/No Transfer: 0/4	4	7

The data suggests a preference towards not transferring in SB-scenarios of strong dominance whilst being indifferent in BS-scenarios of strong dominance. Furthermore, as was mentioned earlier it is quite intriguing how one third of the participants does not have a strong preference towards not transferring in SB-scenarios of strong dominance. Not only does it increase the risk by decreasing the value of the lowest possible payoff (going against predictions of maximin theorem) it also violates dominance. Surely, a rational Chooser would pick DT if a transfer is made in context of strong dominance; hence, a rational Decider should never make such transfers. It is worthwhile to consider a replication study of the experiment solely to assess whether this finding persists in a larger data sampling.

Weak dominance

When we look at scenarios in which 20 tokens can be transferred we have only half as much data available compared to the scenarios of strong dominance (and compared with scenarios without dominance). This is simply due to our design having two values for scenarios of strong dominance (and for scenarios without dominance) whilst weak dominance can only be assessed with one specific transfer amount [42]. In Table 35 we explore Decider-behaviour in scenarios of weak dominance.

Table 35: Decider behaviour in presence of weak dominance

	BS	SB
Transfer/No Transfer: 2/0	13	5
Transfer/No Transfer: 1/1	8	6
Transfer/No Transfer: 0/2	3	13

In scenarios of weak dominance behaviour appears to be strongly influenced by the directionality. In BS-directionality the majority of P1s makes the transfer consistently whilst in SB-scenarios the majority of P1s does not transfer. It is noteworthy that about one fifth of our Openers makes a consistent transfer decision in SB-scenarios despite weak dominance.

Without dominance

Finally, we look at scenarios without dominance (i.e. when the transfer amount is five or ten tokens) (see Table 36).

Table 36: Decider behaviour in scenarios without dominance

	BS	SB
Transfer/No Transfer: 4/0	7	5
Transfer/No Transfer: 3/1	6	4
Transfer/No Transfer: 2/2	8	5
Transfer/No Transfer: 1/3	2	9
Transfer/No Transfer: 0/4	1	1

In scenarios without dominance the BS-type appears somewhat more likely to transfer compared to the SB-type. However, these differences do not appear to be

[42] It is true that we could use different amounts for the two boxes or simply provide more trials with twenty tokens as transfer amount, however, we consider the current approach more simplistic for exploratory purposes and find it more natural to have less weak dominant scenarios than scenarios for strong dominance and scenarios without dominance.

too prominent with similar frequencies observed for SB one cell lower in the table compared to BS.

Chooser behaviour

Based on predictions from theoretical frameworks introduced earlier we expect Choosers to behave according to a specific profile. We discuss the possible profiles starting with scenarios of strong dominance[43].

Table 37: Chooser profiles for strong dominance

	Strategy	Frameworks
Profile 1	Always pick DT	Nash_A, Nash_N, Level2_A
Profile 2	Transfer: DT No transfer: Random	Level2_N, maximin

Table 38: Chooser profiles for weak dominance

	Strategy	Frameworks
Profile 1	Always pick DT	Nash_A, Nash_N, Level2_A, Level4_N
Profile 2	Transfer: DT No transfer: Random	Level2_N, maximin

Table 39: Chooser decisions without dominance

	Strategy	Frameworks
Profile 1	Always pick DT	Nash_A, Nash_N
Profile 2	Transfer: DT No transfer: Random	Level2_N, maximin
Profile 3	Transfer: DT No transfer: DF	Level3_A
Profile 4	Transfer: DF No transfer DT	Level4_N, Level1_A

Table 40 provides the reader with an overview of the choice profiles for P2; the raw assessments can be found in Appendix 2.4. We stress that we only assess strategy profiles for the dominance levels on which they are predicted by one of the frameworks as discussed earlier. Thus, we do not assess profile 3 or 4 in scenarios of strong and weak dominance.

Table 40: Overview of the profiles for P2

	Strong dominance	Weak dominance	No dominance
0	NA	NA	NA

[43] Note that Nash also allows P2 to pick probabilistically as long as she has a strong enough preference for DT such that P1 does not desire to deviate. However, due to the added complexity and our limited number of trials we discount this option from our discussion.

1	Profile 2	NA	NA
2	NA	NA	Profile 4
3	NA	NA	Profile 4
4	Profile 2	NA	NA
5	Profile 2	Profile 1	NA
6	Profile 2	NA	NA
7	NA	Profile 2	NA
8	NA	NA	Profile 2
9	Profile 2	NA	NA
10	Profile 2	NA	NA
11	NA	NA	NA
12	Profile 1	NA	NA
13	NA	NA	NA
14	Profile 1	Profile 2	Profile 1
15	Profile 1	NA	NA
16	NA	NA	Profile 4
17	Profile 2	NA	NA
18	NA	NA	NA
19	NA	NA	NA
20	NA	NA	Profile 3
21	NA	NA	NA
22	Profile 2	NA	NA
23	NA	NA	NA

In this table we allowed for a slight trembling hand phenomenon in scenarios of strong dominance and scenarios without dominance but not for scenarios of weak dominance (since weak dominance involves only half the number of trials compared with the other dominance levels). Furthermore, profile 2 involves a ‘random’ choice for scenarios where the transfer is not made; allowing for a slight trembling hand can be somewhat ambiguous in this context since other profiles are similar but with a non-random prediction for that same scenario. Thus, the reader should keep in mind ‘profile 2’ codings under strong dominance or without dominance may alternatively be interpret as ‘profile 1’ or ‘profile 3’ at occasions. Another remark is that all four profiles are predicted at times by level k models which the reader should keep in mind.

The column of strong dominance observes the predicted profiles the most frequently; however, even for scenarios of strong dominance 54% of the sample is not categorized under the profiles which are suggested by theory. Furthermore, there does not appear to be a consistent pattern of strategy profiles across dominance levels when we look at the data for unique participants.

The Chooser’s experimental behaviour is summarized in Table 41.

Table 41: Chooser behaviour

Transfer amount	Transfer		No Transfer	
	DF	DT	DF	DT
35	5	30	29	32
30	7	34	24	31
20	19	31	25	21
10	35	26	18	17
5	29	25	17	25

We assessed a potential relationship between the Chooser's decision and the Decider's transfer choice. This is done separately for scenarios of strong dominance, weak dominance and scenarios without dominance. Since the frequency in which Choosers encounter certain scenarios depends upon the actions of Deciders we provide simplified tables for our analysis whilst the raw tables are provided in Appendix 2.5. Furthermore, it is possible that a particular Chooser never encounters a specific scenario. As concrete example, consider a scenario in which the Decider-opponents for a certain Chooser all decide not to transfer under weak dominance; as a result we cannot assess how this Chooser behaves in scenarios of weak dominance when the transfer is made). Whenever this happens the Chooser is coded as 'unobserved'. We first discuss scenarios with strong dominance.

Strong dominance

In Table 42 we contrast the frequency in which DF versus DT is chosen for scenarios of strong dominance. Data is separated depending on the Decider's decision (i.e. whether the transfer is made or not).

Table 42: P2 decisions in scenarios of strong dominance

	Transfer	No Transfer
Freq(DF) > Freq(DT)	0	7
Freq(DF) = Freq(DT)	2	3
Freq(DF) < Freq(DT)	22	13
Unobserved	0	1

We observe a very strong preference for DT-choices when transfers are made. When transfers are not made we observe a less extreme preference towards DT.

Weak dominance

Next, we discuss Chooser behaviour in scenarios of weak dominance (see Table 43).

Table 43: P2 decisions in scenarios of weak dominance

	Transfer	No Transfer
Freq(DF) > Freq(DT)	7	10
Freq(DF) = Freq(DT)	4	3
Freq(DF) < Freq(DT)	13	9
Unobserved	0	2

In scenarios of weak dominance there also appears to be a preference for DT when a transfer is made. When no transfer is made Choosers appear indifferent in scenarios of weak dominance.

Without dominance

Finally, we assess Chooser behaviour in scenarios without dominance (see Table 44).

Table 44: P2s behaviour in scenarios without dominance

	Transfer	No Transfer
Freq(DF) > Freq(DT)	13	9
Freq(DF) = Freq(DT)	2	4
Freq(DF) < Freq(DT)	9	10
Unobserved	0	1

In scenarios without dominance Choosers may have a small preference towards DF when transfers are made (though this could simply be noise) whilst they are indifferent if no transfer is made. .

Next, we discuss Experiment Three which uses verbal protocols to explore reasoning processes.

Experiment Three

Differences between Experiment Two and Experiment Three

Whilst Experiment Two provides preliminary data on behaviour in the Transfer Game it remains unclear *why* the behaviour occurs. For example, the Decider may not make a twenty token transfer in SB-directionality because (a) he notices the weak dominance involved with such a transfer, (b) he considers it risky to transfer that much in SB-directionality, (c) he rather has a minimum of forty tokens than a minimum of twenty tokens, (d) he thinks that not transferring leads to a better payoff due to bluffing and double-bluffing ideas. To have a better insight into the reasoning processes underlying behaviour we created Experiment Three in which the experiment is played in two-player teams. Choices have to be coordinated with a teammate and we can collect data on reasoning processes in a non-obtrusive way by looking at the discussions from each team's private chat-room. The main differences with the experimental set-up of Experiment Two are that we now have (a) a chatting window, (b) a countdown clock, (c) a confirmation message of the currently selected choice and (d) a penalty system in which the team receives zero tokens on trials in which they fail to make a uniform choice in the allotted timeframe (to further incentivise coordination).

Our main goal from Experiment Three is thus to gain better insights into choice behaviour by collecting reasoning processes through verbal protocols. Before we discuss the findings from Experiment Three we point out to the reader that a comparison between individual data from the second experiment and team data from the third experiment is found in Appendix 2.6. We do not focus on team versus individual play within this chapter since data from the third experiment is quite limited and only descriptive comparisons can be made. For our exploration of the verbal protocol design we coded the chat logs of each team on the reasoning, bluffing ideas and dominance awareness (see Appendix 2.7). This coding was done solely by the author (given that it is a pilot experiment on verbal protocols) though future versions could employ independent coders.

Participants

Participants for Experiment Three were 36 students and employees from Warwick University, with an average age of 21 years old. These participants were grouped into two-player teams who had to make their decisions in unison resulting into an actual sample size of 18 teams (N=18). Our overall sample (across Experiment Two and Experiment Three) was predominantly female (27 female, 16 male)[44]. Recruitment was done through SONA, an online system for participant recruitment. We decided in advance on the sample size and had twelve participants in each of three experimental sessions. Each session consisted of exactly twelve participants which were grouped into six two-player 'teams'. To avoid cancelling sessions due to participants not showing up we recruited four additional participants per session; if more than twelve participants showed up before the starting time we randomly selected participants to be send home with a £2 show-up fee. The possibility of being send home (due to an exact number of participants being required for the study) was advertised on SONA when participants signed up. Excluding participants happened through a procedure of shuffling a deck of cards (containing the cubicle numbers of all occupied computers) and randomly drawing one or more cards.

Participants were paid a show-up fee (£2) and an additional performance fee (£0.50-£11.50) based on a random lottery incentive system. The expected pay-off for the average participant is £8; and the average participant earned £6.88. Participants are told during an introductory PowerPoint explanation that they earn a performance fee based on the amount of tokens won in a randomly selected trial. We did not inform participant of the conversion rate (tokens to pounds) to avoid potential biases due to monetary expectations. Each token that is won in the randomly selected trial translated into an additional £0.10 in performance fee. We did not provide participants with details regarding the random selection procedure for the 'performance fee' trial; concretely, a python script randomly selects a trial per 'team' to base their performance fee on. Different teams can be remunerated upon performance in different trials but participants who play in the same team receive the same performance fee for fairness reasons.

Materials

The experiment was performed in the Behavioural Science Lab; the coding was done by the author using a combination of python, HTML/CSS and willow. Additionally, HexChat software was used to create separate and anonymous chat

[44] Note that we have missing information on the demographics of part of the sample due to maintenance of the SONA database requiring participants to redo their prescreen demographics yearly which isn't always done.

rooms for each two-player team. Participants face a total of six trials; and they swap between being in the role of P1 and being in the role of P2 on each consecutive trial to maximize both fairness and exposure to both roles. The six trials are summarized in Table 45)[45].

Table 45: Trials in Experiment Three (i.e. chat variation)

Dominance level	Role	Directionality	Transfer Amount
No dominance	P1/P2	BS	5
No dominance	P2/P1	SB	10
Weak dominance	P1/P2	SB	20
Weak dominance	P2/P1	BS	20
Strong dominance	P1/P2	BS	30
Strong dominance	P2/P1	SB	35

Trials of each role are randomized separately and are zipped together such that participants change role on consecutive trials. Transfer amounts for the experiment were chosen such that we have one trial representing scenarios without dominance (i.e. 5 or 10), one trial representing scenarios with weak dominance (i.e. 20) and one trial representing scenarios with strong dominance (i.e. 30 or 35) in either role; with the transfer amounts differing between roles when possible. Given that participants were already divided in two-player teams we did not subdivide experimental sessions into 'mini sessions' for this experiment (in contrast with our other experiments). Every trial teams are randomly re-matched with another team and they do not know who they are matched with. Their own team remains the same throughout the experiment but they do not know the identity of their teammate. We did not drop variables, conditions or trials from our analysis.

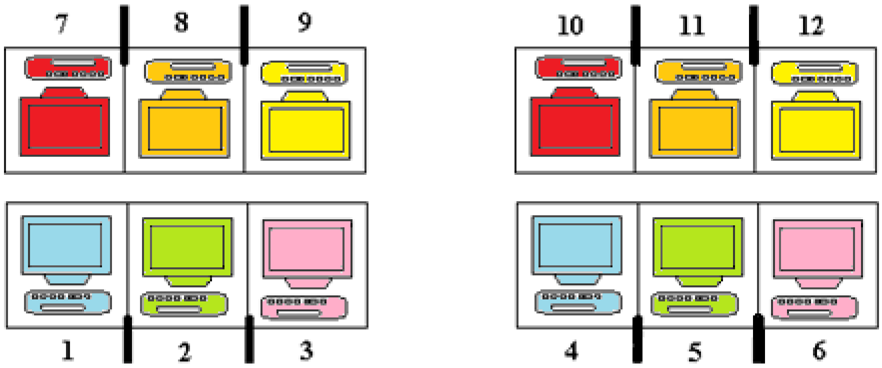
Procedure

The experiment consisted of three sessions with twelve participants per session (N=36 participants or 18 teams). A 75-minute timeframe was available for each session and sessions typically lasted 60 minutes. Using an alphabetical listing of signed-up participants we allocated everyone to numbered cubicles. The experiment is set-up such that adjacently seated participants have the same starting

[45] Similarly to the first experiment teams change their role on consecutive trials. Furthermore, in each role the team faces one trial involving strong dominance, one trial involving weak dominance and one trial without dominance; and the directionality in which you face trials of a specific dominance level as P1 versus P2 is reversed.

role; though they are unaware of this feature. Furthermore, teammates are seated three seats away from one another as is indicated by a colour scheme in Figure 56.

Figure 56: Experimental Setup



This figure provides a schematic overview of our experimental layout. Participants sit in two rows of desks each with a computer. Shutters (partitions) are used such that they can only see their own computer. Participants in the same row (e.g. 1-6) start the experiment in the same role. Teammates are separated by two participants as is indicated by the colour of computer monitors. The same monitor colour indicates that participants are on the same team.

If more than twelve people showed up we would randomly exclude participants by blindly selecting a cubicle number from a pack of numbered cards after shuffling the cards in front of the participants. Excluded participants received a £2 show-up fee and filled in a payment receipt after which the doors were closed and the experimental setup was explained by means of a PowerPoint presentation (see Appendix 2.2 for details on instructions). The main points from the PowerPoint instructions are shortly summarized below:

> This experiment is played in two-player teams. We randomly assign you with a teammate who plays in the same role and sees the same information on their computer screen. You can communicate with your teammate through a private chat room. On each trial you have to make decisions together with your teammate by clicking one of two buttons. Your goal is to gain tokens which are converted into a monetary amount at the end of the experiment. If your team does not click the same button or if your team does not make decisions within a two-minute timeframe you are both penalized (i.e. you receive zero tokens on that trial); it is thus important to coordinate with your teammate.
>
> The task itself is as follows. Each trial you see two boxes on the screen. We refer to the left box as Box A and we refer to the right box as Box B. You are informed that one of the boxes contains 40 tokens whilst the other box contains 80 tokens -- but you do not know which box has which token amount. Your team is either assigned the role of Decider (player one) or the role of Chooser (player two). As Decider Team you can look at the true content of the two

boxes and you are presented with a transfer suggestion. The computer suggests a transfer of a predefined token amount in a predefined direction and informs the Decider Team how many tokens would be in either box if the suggested transfer is made. The Decider Team decides whether or not to make the suggested transfer by clicking on the corresponding button. Next, the Chooser Team has to make a decision. This team does not know which box contains which token amount but they know the transfer suggestion and whether or not this suggested transfer was made. The Chooser Team chooses which of these two boxes they want to have for themselves (which decides their own payoff) by clicking the button underneath the desired option. The unchosen option is assigned to the Decider Team deciding their payoff. Feedback is provided after every trial specifying which box your team received and what its final contents are; furthermore, feedback also informs you of the box received by the other team and its content. If a team was penalized this is also mentioned during the feedback stage.

During each trial you are given two minutes to discuss the scenario with your teammate and to make a decision. A countdown clock is displayed on the screen. If no decision is made by one of the teammates (or if the teammates make different decisions) then the team is penalized and receives no tokens on that trial. After each trial your team's role swaps (i.e. Deciders become Choosers and Choosers become Deciders) and you are randomly re-matched with another team for the next trial. However, your teammate remains the same throughout the experiment. A total of six trials is played. Regarding your final payment you receive a participation fee of £2 and additionally you earn a performance fee based on the amount of tokens your team has won in a randomly selected trial.

Participants were given the opportunity to raise their hand if further clarification was required and were informed that they could do so at any time during the experiment if they had further questions. Before starting the experiment participants were asked to put their electronic devices and notes away. Furthermore, between each experimental cubicle we pulled out ‘shutters’ (i.e. partitions) to avoid the temptation of glancing on a neighbour’s computer screen. At the end of the experiment pay-offs were calculated using a python script. Concretely, the script randomly generates a trial number for each participant and assesses how many tokens they won on that particular trial. Tokens are multiplied by a factor of 0.1 to generate the performance fee and a two pounds show-up fee is added in. The python script does this for every 'team' and makes a clean output file with a summary of individual cubicle numbers and payments.

Finally, participants fill in receipts for payment and are asked to come forward when we call their cubicle number to receive payment in exchange for their receipt ticket. Data from the experiment is stored in a time-stamped folder containing a multitude of CSV-files (i.e. one for each trial played by each participant ─ in case the program were to malfunction not all data would be lost) and these are converted into a big CSV-datafile using a python script. The data is analysed using RStudio.

Decider behaviour: results from verbal protocols

In this section we discuss the six scenarios that Deciders could face in Experiment Three. We use a simplified notation to refer to the six scenarios; for example we use the term BS30 to refer to the scenario in which 30 tokens can be transferred in BS-directionality. This section consists of two parts. First, we discuss a summary table of the verbal protocol findings. This table was computed by encoding every trial played by every team using the coding scheme specified in Appendix 2.7. A full trial-by-trial version of the table can be found in Appendix 2.8. and the raw verbal protocol data can be found in Appendix 2.9. Afterwards, we provide an overview of the verbal protocols using quotations.

We separated Table 46 into three sections using a colour pattern. Reasoning coding has a white background, bluffing coding has a light-grey background and dominance awareness coding has a dark-grey background. Additionally, we use a salmon-colour to indicate the sentiment that the transfer amount is too small to matter.

Table 46: Summary table for P1

Coding	BS30	SB35	BS20	SB20	BS5	SB10
no reasoning	3	2	3	1	3	2
Equality	0	0	5	0	0	0
Maximin	3	0	1	1	2	3
avoid risk	0	5	0	3	0	1
considers bluff	1	1	0	2	3	2
Looks at EV	0	0	0	0	0	0
Dominance	0	0	0	1	0	0
random guess	0	0	0	0	0	0
not coordinated	1	0	0	0	0	0
did not understand task	1	1	0	1	1	0
not on time	0	0	0	0	0	1
Amount too small	0	0	0	0	4	2
NA	5	6	6	5	3	3
Decrease variance (no bluff)	2	1	1	2	3	5
Increase variance (bluff)	2	2	2	2	3	1
NA	1	1	0	1	9	10
Does not spot dominance	3	8	5	6	0	0
Unclear	5	0	0	1	0	0

Spots dominance	0	0	0	1	0	0
Spots equality	0	0	4	0	0	0

General observations include a decent degree of maximin reasoning across dominance levels. Furthermore, in SB-scenarios we observe a strong focus on risk avoidance. We point out that the BS20-scenario suggests a strong awareness of the equality potential; meanwhile dominance awareness is lacking in other scenarios; some teams even consider it viable to ‘bluff’ in scenarios of dominance. Scenarios without dominance generally induce the feeling that the task is irrelevant since the payoff-difference of transferring is quite small; and despite these small transfer amounts being the sole scenarios where bluffing behaviour is a viable strategy they are not often approached as such.

Next, we provide some quotes from the verbal protocol data to indicate the encoding. Each scenario is faced by nine Decider-teams; however, decisions made by Team 9 are excluded from analysis since this team was extremely confused throughout the whole experiment[46]. We inform the reader that a semicolon (‘;’) is used in quotations to indicate when the speaker changes during the dialogue (i.e. when the teammate’s reply is included). Furthermore, the dialogues refer to ‘Box A’ and ‘Box B’ which is the physical screen location for the payoffs – DT and DF are terms used in this thesis to make clear which box can increment in value (i.e. this differs between trials in Experiment Two). Physical screen location is kept constant in Experiment Three since we did not find behaviourally differences on this in the previous experiment: thus, ‘Box A’ is always DF whilst ‘Box B’ is always DT.

Scenarios of strong dominance in this experiment are either BS30-scenarios or SB35-scenarios. When we look at the BS30-scenario we find evidence for maximin reasoning in three out of the nine teams who faced such scenarios. Concretely, these teams felt as if they would receive the lower payoff regardless their decision and, hence, they rather transfer and receive 50 tokens compared to not transferring and receiving 40 tokens (Team 1: *“I imagine the other team would pick the higher amount”*, Team 13: *“I think the question is do we want 50 or 40”*, Team 15: *“Think we are going to lose this one either way”*). Given the certainty expressed

[46] The experimenter visited them twice during the experiment but they simply failed to communicate and understand the basics of the task. At one trial their dialogue even reveals how one of the teammates says that she will make the transfer whilst the teammate replies “and I will choose (box) A”; suggesting that one of them cannot even assess their own role.

by these teams that they would end up with the shorter straw regardless their decision we had a closer look at P2-choices for trials involving 30 tokens (i.e. to assess whether this was a viable best response strategy or whether it involved a maximin strategy due to pessimistic feelings about the experimental outcome). Data suggests that the teams would have had good odds at earning the larger payoff if they did not make the transfer[47]. Furthermore, we had three teams who did not provide reasoning (Team 2: *"How many tokens are you guys transferring; 30; OK"*; Team 3: *"What do you want to do; Don't transfer; Sure"*; Team 14: *"No transfer; No transfer"*). One team misunderstood each other's intentions (Team 7: *"I say go for it; Risk; And do not make the transfer; OK"*). And a final team considered it viable to make a bluff (Team 8: *"They may think Box A still has more and that is why we transferred"*) – and they were lucky enough to get away with it.

Next we discuss the SB-35 scenario. Four teams considered it too risky to transfer in SB35-scenarios which is sensible since they could end up with five tokens (Team 4: *"If we make a transfer and they opt for Box B we are left with only five tokens"*; Team 10: *"I don't want a probability of getting 5"*; Team 12: *"If we transfer we have a chance of getting just 5"*; Team 16: *"It's too risky to just get 5 tokens"*). However, the fact that such transfers result into a dominant choice for the opponent is seemingly not realised. The team speaks of a 'probability' of receiving five tokens if they make the transfer without realising that any rational opponent would always pick DT in such a scenario – the five tokens would not be a probability, it would be a certainty. Furthermore, one team even considered it a viable idea to attempt bluffing in the SB35-scenario (Team 5: *"How can you make them not choose box B? – lets transfer"*). Two teams did not provide reasoning (Team 6: *"Transfer or not; Transfer";* Team 17: *"Don't transfer; yeah"*). One team misunderstood that they were on the same team leading to communication failures (Team 11: *"Box A=40, Box B=80; Yes, what should I do; Transfer is 35 to Box B"*).

[47] Concretely, whenever a transfer was made involving 30 tokens five out of seven teams picked DT whilst two teams went against the dominance and picked DF; when the transfer was not made two out of two teams picked DT.

One team suggested not to transfer such that the payoff difference doesn't increase (Team 18: *"No transfer to keep a fair balance; yeah"*)[48].

Next, we assess behaviour under weak dominance. When the directionality of the suggested transfer is BS a transfer would equalize the payoff of the two teams. Deciders should thus be cautious to transfer 20 (or more) tokens since rational Choosers are expected to select DT whenever 20 (or more) tokens are transferred (i.e. DT cannot be worse than DF). For BS20-scenarios we find that five out of nine teams are aware of the dominant nature of transferring and aim to equalize the two boxes (Team 4: *"If we transfer both end up getting 60"*; Team 10: *"If we transfer we win for sure 60"*; Team 16: *"We would both get 60"*; Team 17: *"the boxes will balance so it is a win-win"*; Team 18: *"If we transfer we win 60 anyway"*). Three teams did not providing reasoning (Team 11: *"Make transfer; Yes";* Team 12: *"Don't make transfer; Let's not make the transfer"*; Team 6: *"No transfer"*). And one team decided to transfer out of maximin reasoning (Team 5: *"If we transfer we get minimum 60 instead of 40"*).

For SB20-scenarios we see two teams who considered bluffing behaviour (Team 3: *"So the aim is to convince them that Box A has more tokens"*; Team 8: *"Do you think we should trick them this time?"*). One team used a maximin approach (Team 1: *"don't make the transfer and then we get at least 40 rather than 20"*). One team did not provide reasoning (Team 2: *"Are we transferring; I would say no; Alright"*) and another team did not want to take the risk of transferring and considered it equally likely to receive DT as DF when they do not transfer (Team 7: *"We will get 40 or 80 equally likely"*). One team realises the dominance when they make the transfer whilst assuming it a fifty-fifty chance if they do not transfer (Team 13: *"If we make a transfer they will obviously know which box to select. On the other hand not making the transfer leaves them with 50 50 chance"*). Two teams do not want to take the risk of transferring (Team 14: *"A has 40, B has 80. Transfer from A to B is not worth it"*; Team 15: *"Not transfer; In case they choose box B"*).

Finally, we discuss scenarios without dominance. If 5 or 10 tokens are transferred it is not clear to the opponent whether DT versus DF offers the better

[48] This team is coded as 'Avoid risk' in our table; however, the quote is mentioned separately given that it is only one of multiple possible interpretations. It is possible that the team refers to a "fair balance" out of other-regarding preferences for example.

payoff. This means that P1 can engage in bluffing attempts. In BS5-scenarios we often observe the idea that regardless the outcome the difference is marginal (Team 7: *"It's just 5"*; Team 15: *"If we are to lose the margin will be almost the same anyway"*; Team 13: *"It's only five"*; Team 14: *"It won't make a big difference so either way is fine"*). Looking at actual choices we observe three teams who try to trick the opponent (Team 3: *"We should transfer to do the trick thing";* Team 7: *"It effects their decision; I would say do not transfer"*; Team 15: *"Let's not transfer; they will assume Box B was bigger"*). Three teams did not provide reasoning (Team 2: *"I'ld say no; Okay, I'll put no"*; Team 8: *"Transfer; Yeah";* Team 14: *"It won't make a big difference so either way is fine"*). Finally, there were two teams who engaged in maximin reasoning (Team 1: *"Transfer then we at least get 45 rather than 40"*; Team 13: *"Transfer; Yeah, even if they picked the 80 box we would get more than 40 as we have transferred"*).

For the SB10-scenario there were also two teams who considered the amount too small to matter much (Team 17: *"It is only ten"*; Team 18: *"10 tokens is little amount to bluff"*). Regarding decisions we observe two teams who attempted to outsmart their opponents (Team 17: *"We could confuse them and transfer the tokens";* Team 18: *"Stay the same because they will be expecting a bluff; alright, so not transfer"*). Three teams did not want to increase the difference between the payoffs in relation to maximin reasoning (Team 4: *"We at least win 40 better than winning 30 anyways; OK so no transfer"*; Team 6: *"Not make transfer if they choose B we end up getting 30; Exactly"*; Team 11: *"No point making it 30 and 90"*). One team did not want to take the risk of transferring with the idea that the opponent would have a 50-50 chance (Team 5: *"No transfer; then they will have to guess so its 50-50"*) and another team attempted to outsmart their opponent but did not make a choice within the time limit (Team 10: *"We can do the scam; But what if they never think of it being a trap and go for box b"*). Finally, there were two teams who did not provide reasoning (Team 12: *"Let's go with no transfer; no transfer it is";* Team 16: *"Let's not transfer; I agree"*).

Chooser behaviour: results from verbal protocols

In this section we discuss the six scenarios that Choosers can face in Experiment Three starting with scenarios of strong dominance and ending with scenarios without dominance. Scenarios of strong dominance are merged (and the same is done for scenarios without dominance) to make the discussion easier to digest. We use a simplified notation to refer to the six scenarios. 'Transfer30/35' refers to a scenario in which 30 or 35 tokens are transferred. Each of our eighteen Chooser-teams faced one scenario of strong dominance, one scenario of weak dominance and one scenario without dominance. We start this section by illuminating a summary table for Chooser behaviour when the transfer was made (see Table 47) and a summary table for Chooser behaviour when the transfer was not made (see Table 48). Afterwards we illustrate the verbal protocol data using some quotations. We point out to the reader that the columns in our summary table reflect how many tokens are/could have been transferred; and that there is more data in the '20' column since the BS20 and SB20 scenarios are merged together (Choosers do not know the directionality of the suggested transfer) whilst we kept other scenarios such as BS30 and SB35 separated since the amounts differ.

Table 47: Reasoning for P2 when transfer is made

Coding	30	35	20	5	10
no reasoning	2	0	1	1	0
spots dominance	3	2	3	0	0
Spots equality	0	0	3	0	0
looks at EV	0	0	0	2	2
Maximin	0	1	0	0	0
avoid risk	0	0	1	0	0
random guess	0	0	0	2	0
Considers bluff	1	0	0	0	0
did not understand task	1	0	2	0	0
NA	4	2	8	2	2
Assumes transfer means DF > DT (no bluff)	1	0	0	2	0
Assumes transfer means DT > DF (bluff)	2	1	2	1	0
Unclear	1	1	0	0	0
Spots dominance	3	2	6	0	0
Does not spot dominance	2	0	3	0	0
NA	1	0	1	5	2

Choosers have strong awareness of dominance when transfers are made (both under strong and weak dominance). Meanwhile, the focus in scenarios without dominance lies mainly on expected values; despite being an ideal set-up for bluffing behaviour by the opponent this is not something Choosers consider.

Table 48: Reasoning for P2 when transfer is not made

Coding	30	35	20	5	10
no reasoning	1	1	3	1	2
random guess	0	1	1	2	4
Considers bluff	1	3	4	1	0
did not understand task	0	1	0	0	1
NA	0	1	0	0	1
Assumes no transfer means DF > DT (bluff)	0	3	3	3	2
Assumes no transfer means DT > DF (no bluff)	2	2	5	1	4
Does not spot dominance	2	5	8	0	0
NA	0	1	0	4	7

When transfer are not made Choosers refer to scenarios of dominance as 'coin flips' or 'bluffing attempts'; they seemingly fail to realise that it is a rational decision not to transfer in such scenarios. Scenarios without dominance are mostly approached as coin flips when the transfer is not made. Despite being the only viable set-up for bluffing behaviour they are not often seen as such by Choosers.

Next, we illustrate the verbal protocol data through some direct quotes. Decisions made by Team 9 are again excluded since this team was extremely confused throughout the whole experiment. We start with scenarios of strong dominance after which we discuss weak dominance and finally we discuss scenarios without dominance.

Strong dominance

We start by discussing the Transfer35/30-scenarios. Five teams were aware of the dominance involved with a 30 or 35 token transfer (Team 2: *"Are we going to take the box with the highest payment; Yeah; So it is Box B; Yeah"*; Team 7: *"Definitely Box B, then we are guaranteed at least 75 or 115";* Team 10: *"All the possibilities turn to Box B being the better choice"*; Team 16: *"Box B surely, it's going to have either 80 [initially already] or 70 [at minimum]"*; Team 17: *"I can't see why they did that transfer, in any way Box B will have more; I guess they thought better win 50 than 40"*). One team did not notice dominance and tried to logically explain the opponents transfer decision (Team 12: *"They won't transfer so many knowing if we select Box B they get Box A, Box A has to be better; Fair enough"*). One team used a maximin strategy and picked DT since it would have a minimum content of at least 35 tokens (Team1: *"We should choose Box B we know at least we* *will have 35")*[49]. Furthermore, we had two teams who did not provide reasoning as to why they chose DT (Team 4: *"Do we go Box B; yeah I think so"*; Team 5: *"Shall we take Box B; Okay"*) and a final team which was confused about the task (i.e. didn't understand they were talking with a teammate instead of an opponent) (Team 11: *"How many are in each, 50/50"*).

Next, we assess the NoTransfer35/30-scenarios. One team considered it to be a random guess (Team 3: *"What's your favourite letter A or B, lol"*) whilst two teams considered the rejection of the suggested transfer to be an indicator that DT initially had the 80 tokens (Team 14: *"Should we choose Box B, because Box B had 80 and Box A had 40";* Team 18: *"I think they were conservative and didn't leave Box A with only 10; So you think Box A has 40 tokens"*). Finally, we had one team who chose DF with the idea that their opponent may be playing a trick suggesting that they are unaware of the dominance involved with such a large amount (Team 8: *"They could be tricking us, if they did not transfer they might want us to think Box B already has more, let's go with Box A"*) and another team who assumed the opponent is not trying to trick them and chose DF for that reason (Team 13: *"They didn't transfer from Box A to Box B, are we saying Box A has more; Yeah, I think so, unless they are trying to trick us"*)[50]. Finally one team provided no reasoning with at least one teammate being indifferent (Team 15: *"What shall we pick, Box A; Let's do Box B; Cool"*) and another team simply did not provide reasoning (Team 6: *"What are we choosing; B; I picked B"*)

Weak dominance

Now we focus on scenarios involving weak dominance. We start by discussing Transfer20-scenarios. There were nine Transfer20-scenarios and eight NoTransfer20-scenarios. Six teams realise the dominance involved with the transfer (Team 2: *"Either it was A80 B40 and its now 60/60 or it was A40 B80 and its now*

[49] This team did not mention the initial minimum value of the DT-box at all times (i.e. at the start of the game DT must have at least 40 tokens already; thus DT has at minimum 40+35 tokens if the transfer is made). However, this may simply be a typo of '35' instead of '75'.

[50] This team clearly made a mistake in their reasoning since, surely, DT would be the option with the larger payoff when a no-transfer decision is interpret as 'non-trickery' (when participants are not aware of the dominance involved). If DF had the larger payoff and no transfer was made then the reasoning should be that it is a trick – not inversely.

20/100, right"; Team 4: *"If it started with 40 then it now has 60 or if it started with 80 then it now has 100"*; Team8: *"Transferring 20 from 80 or 40 works fine for us either way, equal or more"*; Team 13: *"If Box B had 80 then it now has 100 and if it had 40 then both boxes have 60"*; Team 14: *"I think choose Box B; Both have the same amount so doesn't matter"*; Team 15: *"Either B will be 100 or 60"*). One team was confused early on and decided to choose DT out of simplicity (Team 11: *"Let's just keep the boxes as equal as we can and choose the one it transfers to"*) whilst another team considered it risky to pick DF (Team 1: *"It will be risky to pick Box A; Let's do Box B"*). A final team did not provide reasoning (Team 12: *"Let's take Box B; Sure"*).

Next, we discuss NoTransfer20-scenarios. Four teams considered bluffing logic assumed (Team 3: *"I feel like if they declined then they want more tokens, but they could be doing your trick";* Team 10: *"I feel like the possibility that a transfer was declined is maybe if they did Box A would have the 40 tokens; I don't know we just have to gamble on this one"*; Team 17: *"My guess is that they had 40 in Box A and didn't want to transfer"*; Team 18: *"My bet is that the 80 are in the B Box; Actually yeah I agree"*). One team considered it a guess (Team 7: *"Just a guess really; Hmmm… Box B; Yeah, I would say so"*). Finally there were three teams who did not provide reasoning (Team 5: *"Shall we take Box A; I was thinking so"*; Team 6: *"I picked Box B; Box A; I picked Box B";* Team 16: *"Should we pick Box A; I think so"*).

Without dominance

Finally, we discuss the scenarios without dominance. We start by discussing the Transfer10/5-scenarios. There were four teams who simply looked at the expected values of the two boxes (Team 8: *"I think Box B, it will either be 50 or 90 tokens"*; Team 13*: "Box B is either 50 or 90 whereas Box A is either 30 or 70";* Team 10: *"If we pick Box A we either have 75 or 35 if we pick Box B we either have 85 or 45; Box B; Both options are higher in Box B with 50/50 chances"*; Team 18: *"Could be everything, 50/50; If we go for Box B and it started at 40 it's now 45 and if it started at 80 it's 85, Box A is either 35 or 75 so I say go Box B"*). Then there were two teams who considered it a random guess (Team 5: *"I think Box A might be* *larger, but it's a guess"*; Team 11: *"It's so difficult to tell other people's strategy"*). And a final team did not provide reasoning (Team 6: *"Box A; Ok"*).

Next we look at the NoTransfer10/5-scenarios. Six teams consider it to involve luck and make a random guess (Team 1: *"I'm thinking Box A but I'm not 100% confident; Let's do Box A then";* Team 3: *"Let's stick to tradition; Can't really tell if they wanna lure us or not; Let's pass it to fate"*; Team 7: *"I really don't know"*; Team 15: *"Either one could have more";* Team 12: *"This is a coin-flip"*; Team 16: *"I have no idea; Okay random guess Box B then"*). One team considers it a trickery attempt (Team 4: *"I think they want us to think there is more in Box B so they didn't transfer"*). And three teams did not provide reasoning for their decisions (Team 2: *"Which box are you picking; I don't know; Pick Box B I think"*; Team 14: *"Choose Box A; Yes";* Team 17: *"We are not losing much; Because it is only 5; I agree"*[51]).

Across roles

We end this section by focussing on behaviour and reasoning across roles. Firstly, we discuss dominance-awareness across trials and secondly we discuss whether teams consistently reason according to particular frameworks. Regarding dominance we looked for consecutive trials which both involved dominance; Table 49 offers a summary – which is based on the full codings from Appendix 2.8.

Table 49: When consecutive trials were both scenarios involving dominance

First trial	Second trial	Scenario1, Scenario2	Team
Spotted Dominance	Spotted Dominance	SB20 – Transfer / BS20	Team 4
		BS20 / BS30 – Transfer	Team 16, 17
		BS20 / BS30 – No transfer	Team 18
	Unclear	SB35 – Transfer / SB20	Team 2
		BS20 – Transfer / BS30	Team 13, 14, 15
	Not Spotted	SB35 – Transfer / SB20	Team 7
		BS30 – Transfer / SB35	Team 10
		SB20 / SB35 – No transfer	Team 13
Unclear	Spotted Dominance	BS30 / SB35 - Transfer	Team 2
		SB20 / BS20 - Transfer	Team 2
	Not Spotted	BS30 / SB35 – No transfer	Team 3
		BS30 – Transfer / SB35	Team 5
Not	Spotted Dominance	SB35 / SB20 - Transfer	Team 4

[51] It is slightly odd to comment on the five token transfer amount when the transfer is not made as argument; it is unclear whether the team wrote a typo or whether some innuendo is present such as "regardless whether they transferred or not would not affect things".

Spotted		BS30 / SB35 – Transfer	Team 7
		SB20 / BS20 - Transfer	Team 8
	Not Spotted	BS30 / SB35 – Transfer	Team 1
		BS30 / SB35 – No transfer	Team 8
		BS30 – Transfer / SB35	Team 4, 12
		BS30 – No Transfer / SB35	Team 6
		SB35 / SB20 – Transfer	Team 12
		SB35 / SB20 – No transfer	Team 5, 6, 10
		SB35 – No transfer / SB20	Team 3, 8
		SB35 – Transfer / SB20	Team 1
		SB20 / BS20 – No transfer	Team 3, 7
		SB20 / SB35 – No transfer	Team 14, 15
		SB20 / BS20 – Transfer	Team 1
		SB20 – No Transfer / BS20	Team 5, 6, 10
		SB20 – Transfer / BS20	Team 11, 12
		SB20 – No transfer / SB35	Team 16, 17, 18

There were eleven cases in which dominance was recognised on the first of the two trials. It seems quite straightforward to expect participants to be aware of dominance on the consecutive trial if they were aware of it on the first trial. Four of these also had dominance-recognition on the second trial; for another four trials it was unclear whether dominance was spotted on the second trial and for three trials dominance was not spotted on the second trial[52]. Choosers are less likely to spot dominance when the transfer is not made; meanwhile, Deciders are less likely to spot dominance when the directionality is SB.

Finally, we looked at consistency of choices across trials. A study by Colman et al. (2014) explored self-reported reasons as to why participants made certain decisions in context of twelve cooperative games. These self-reports indicated that roughly 80% of participants used two or more types of reasoning within the same game. Furthermore, our individual version of the Transfer Game suggested that participants often do not make predictions according to specific frameworks in trials involving the same dominance level whilst even less consistency is found across dominance levels. Using our verbal protocols we looked at consistency of reasoning across trials. We point out to the reader that we only have data on six trials per team (due to the temporal limitations for the experiment) which only allows an assessment

[52] When dominance was spotted twice the second trial involved weak dominance (1x), strong dominance with a transfer made (2x) and strong dominance with the transfer not made (1x); when it was unclear on the second trial the second trial involved weak dominance in SB-directionality (1x) and strong dominance (3x). When dominance was not spotted on the second trial it involved weak dominance in SB-directionality (1x), strong dominance in SB-directionality (1x) and a strong dominance trial in which the transfer was not made (1x).

across dominance levels. We looked at the number of unique ‘codings’ that each team received as a way to assess the consistency of their choices (for this assessment we refer to the overview table from Appendix 2.8). Teams that are coded as “no reasoning provided” or “did not understand the task” on three or more of their six trials were excluded from this assessment[53]. Out of the remaining 13 (out of 18) teams seven are coded in at least four different ways (across their six trials – not including “no reasoning” codings); three teams are coded in three different ways and two teams are coded in two different ways (i.e. Team 3 and Team 17). We thus conclude that researchers should be wary of attempts to explain experimental behaviour by a single theoretical framework; furthermore, we suggest a broader usage of verbal protocols and self-reported behaviour to better grasp how participants themselves approach the task and how this differs between trials with a same or different structure. It may be that consistency is found after a large amount of trials – especially for our verbal protocol experiment we cannot make strong conclusions – however, it seems warranted to further explore these ideas.

Across experiments

In this section we summarize findings across the two experiments. Our aim is to point out similarities and differences and to explain why behaviour may be observed in certain scenarios from Experiment Two based upon the verbal protocol data we collected on the same scenarios from Experiment Three. We start by discussing Decider behaviour after which we discuss Chooser behaviour and behavioural consistencies across the two roles.

Decider behaviour across experiments

We discuss scenarios chronologically from strong to weak dominance. In Experiment Two we observed that two thirds of SB-scenarios result into no transfer decisions which we can explain through a perspective of maximin thanks to the reasoning data collected in our second experiment. Meanwhile, Experiment Two suggested roughly the same degree of transferring and not transferring under strong

[53] These are teams 2, 6, 9, 12 and 14.

dominance. From the reasoning data of Experiment Three we can deduce that a large proportion of the BS-transfer decisions are due to maximin strategies. Furthermore, reasoning data suggests that a proportion of the transfer-decisions in both BS and SB-scenarios of strong dominance may be due to ‘trickery’ attempts.

When we look at scenarios of weak dominance we observed a relatively sharp preference for BS20-transfers in experiment one; this may be due to the ease of spotting dominance in such scenarios given that the majority of BS20-teams from Experiment Three displayed an awareness of dominance combined with a desire to make the payoffs equal. The SB20 trials from Experiment Two suggested that two thirds of participants prefer not to transfer which appears to be due to feelings of high risk according to Experiment Three; meanwhile the transfers that are made could easily be explained as ‘bluffing’ attempts since three (out of nine) teams from Experiment Three attempted to trick their opponents in SB20-scenarios. Furthermore, the chatting data suggests that it is a lot harder for participants to realise dominance in SB20-scenarios compared with BS20-scenarios.

Finally, we discuss the scenarios without dominance. In Experiment Two we observed a preference for transferring in BS-scenarios and seemingly indifferent behaviour for SB-scenarios. Furthermore, the transfer preference for BS is slightly stronger for BS10-scenarios compared with BS5-scenarios. From our verbal protocols we learn that many teams consider the five and ten token amounts too small to effectively influence their payoffs – which intuitively affects scenarios involving five token transfer amounts more strongly. Furthermore, it is quite intriguing how different teams attempted trickery in these trials through opposing assumptions. Two BS5-teams attempted trickery by transferring whilst two other BS5-teams attempted trickery by not transferring; similarly, one SB10-team attempted trickery by transferring whilst another SB10-team attempted trickery by not transferring. It is clear that some teams aim to trick their opponents in scenarios without dominance but it is somewhat ironic that no consensus exists as to ‘what’ trickery behaviour would entail. The best explanation for their diverging understanding of trickery behaviour would, of course, be a differential level of reasoning from a level k perspective. Finally, we note that three out of nine SB10-teams did not transfer simply to avoid increasing the payoff difference. This was a common finding for SB-trials across dominance levels; which aligns well with maximin behaviour.

Chooser behaviour across experiments

In scenarios of strong dominance for which the transfer was made in Experiment Two we mostly see DT-decisions. Looking at verbal protocol data we observe five teams who pointed out the dominance and one team who chose DT since it offered a minimum of 35 (i.e. this may potentially be a typo meant to be '75') tokens. One team chose DF with the idea that the opponent would not make such large transfers if DF is not better. The data from Experiment Two suggests a slight preference towards DT when no transfer is made. Verbal protocol data suggests that this may be a random choice (one team concluded this), that it implies an SB-directionality and thus DT is the better decision (two teams concluded this), whilst an expectation of both trickery and non-trickery is used to argue in favour of DF-choices.

For scenarios of weak dominance we only observe a slight DT-preference when transfers are made in Experiment Two. This contrasts quite strongly with the verbal protocol findings in which most teams realise dominance whilst other teams also pick DT for reasons such as 'risk'. Furthermore, when no transfer is made Experiment Two shows a slight favouring for DF-decisions whilst the verbal protocols suggest somewhat of a preference towards DT with reasoning suggesting that the transfer may be rejected due to an SB-directionality. One potential reason why we see a mismatch between Experiment Two and Experiment Three for twenty token-scenarios relates to the task now involving two people. Only one teammate needs to realise dominance to demonstrate the logic to their teammate making it more likely for teams in general to realise dominance.

In scenarios without dominance we observe a slight DF-preference when transfers are made and perhaps a slight DT-preference when transfers are not made. Looking at reasoning processes from Experiment Three we see that the majority of Chooser-teams looks at expected values when the transfer is made (providing an odd contrast with data from experiment one – where DF was preferred when the transfer is made) whilst a few teams consider it a random guess. When the transfer is not made the majority of teams considers it a game of luck.

Behavioural consistency

Awareness of dominance does not persist across trials. When we assessed consistency of behaviour within trials of a certain dominance level in Experiment Two we observed some behaviour in line with predictions from popular frameworks however many participants do not appear to behave consistently according to the same frameworks. Furthermore, Participants adhering to predictions do not seem to do this consistently across dominance levels; different reasoning patterns may guide behaviour depending on the structure of the game. This may relate to the finding by Colman et al. (2014) that behaviour could be explained best through a combination of frameworks and that certain frameworks work better in simpler settings (e.g. a 2x2 or a 3x3 game matrix) whilst other frameworks are more effective in more complex games (e.g. 4x4 game matrixes). For example, it may be more straightforward for participants that dominance is involved when they are presented with a twenty token transfer in BS-directionality allowing dominance to guide behaviour whilst a thirty token transfer might make features such as ‘risk’ more salient to guide decision making resulting to higher adherence to strategies such as maximin.

Conclusion

This chapter provides us with insights into behaviour in a novel competitive game. Additionally to our base game (Experiment Two) we use an approach of verbal protocols (Experiment Three) to gauge how participants experience the game and what their reasoning processes are. Furthermore, we assessed whether theoretical frameworks are used consistently across trials. Findings suggest that small transfer amounts are often discounted since they cannot affect payoffs in a strong way; furthermore, dominance is not spotted as easily as would be expected for a simplistic game. It should appear relatively straightforward that a transfer of 30 tokens always implies a better DT-value compared with the DF-value; however, it is often easier for participants to realise weak dominance than strong dominance. Furthermore, awareness of dominance on one trial does not result into awareness of dominance on the consecutive trial; for example, it should be easy to discover that a thirty token transfer is ill-advised when one discovered on the previous trial that a twenty token transfer consistently leads to a better DT-value. Regarding theoretical consistency we observed in Experiment Two that many participants do not make systematic choices in the same context (i.e. involving a same dominance level and directionality when looking at Decider behaviour; or involving a same dominance level and transfer decision when looking at Chooser behaviour). Furthermore, theoretical adherence across dominance levels is even less prevalent. From Experiment Three we learned that participants reason differently about the task depending on the concrete scenario they face (though we only have six trials to assess this on). This somewhat relates to the finding by Colman et al. (2004) that behaviour is explained best by a combination of different frameworks and that certain frameworks work better in simpler settings (e.g. a 2x2 or a 3x3 game matrix) whilst other frameworks are more effective in more complex games (e.g. 4x4 game matrixes). For example, it may be more straightforward for participants that dominance is involved when they are presented with a twenty token transfer in BS-directionality allowing dominance to guide behaviour whilst a thirty token transfer might make features such as ‘risk’ more salient in guiding decision-making. Furthermore, we consider it extremely useful to explore reasoning for experimental games. It can help fine-tune designs by identifying potential weaknesses (e.g. many participants do not consider the transfer amounts from scenarios without dominance large enough to affect payoffs) and may explain behaviour in ways that were not considered previously.

Chapter 4 Suitcase Game: a game of trickery, equality and information

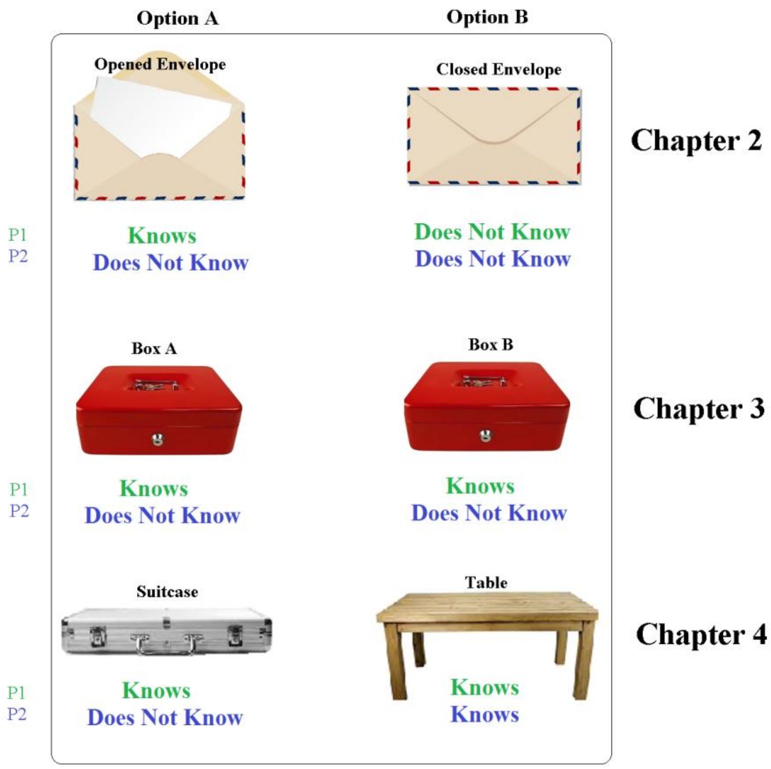
Abstract

In the previous chapters we introduced the reader to two novel competitive games. We consistently looked at the same theoretical frameworks (i.e. Nash, level k and maximin) to explore experimental predictions and we concluded that behaviour does not consistently relate to a specific framework. Additionally, we discussed risk attitudes and verbal protocols as potential procedures to help explain observed behaviour. In the current chapter we introduce a final competitive game. Our exploration for this chapter centers on a number of hypotheses. Furthermore, we assess how behaviour is affected by the provision of additional knowledge.

Introduction

In the previous chapters we discussed two competitive games in which Player One (P1) divides an amount into two shares whilst Player Two (P2) decides who receives which share as their pay-off. The current chapter introduces a third game with this set-up. Each of the three games involves a different degree of knowledge as is described in Figure 57.

Figure 57: The relationship between the Envelope, Transfer and Suitcase Game



In the Envelope Game (chapter 2) P1 knows the value of one of two envelopes whilst P2 did not know the value of either envelope; in the Transfer Game (chapter 3) P1 knows the value of two boxes whilst P2 does not know the value of either box. In the current paradigm P1 knows both the value of a 'suitcase' and a 'table' whilst P2 solely knows the value of the table. Clearly, the three games have strong relationships as they fill the gaps between games of perfect information and games of imperfect information[54].

Paradigm

In the current chapter we refer to the pay-off options as 'suitcase' and 'table'. The initial set-up is such that the suitcase contains an unknown amount of valuable tokens (referred to as the 'distribution amount' or DA) whilst the table contains zero tokens. P1 privately opens the suitcase and his task is to split the DA in two parts. One part is placed on the table whilst the remainder is kept in the suitcase (see Figure 58).

Figure 58: P1's task

[54] We point out to the reader that the moves made by nature are not observed by the second player; in the envelope game the first player even suffers imperfect information.

This figure illustrates the experimental task for the Splitter.

P2 does not know the (remaining) value of the suitcase but she knows how many tokens have been transferred to the table. Her choice is to decide between the suitcase amount and the table amount (see Figure 59).

Figure 59: P2's task

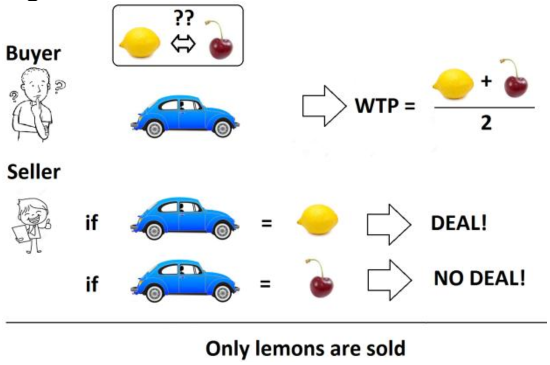
This figure illustrates the task for the Chooser.

So far we omitted one crucial aspect of our paradigm. Concretely, participants are provided with additional knowledge on half of their trials. This knowledge comes in the shape of two numerical values which we refer to as “Announced Values” (AV) throughout this chapter. The AVs are consistently represented in symbolic forms of ‘S’ and ‘L’ (i.e. Small and Large AV). It should be clear that both players receive AVs on the same trials and that they receive the exact same AVs. The reader may remember that we also provided additional knowledge in previous chapters. In the Envelope Game (chapter 2) participants knew the minimum value of each envelope and the sum of the three envelopes[55]; and in the Transfer Game (chapter 3) we told participants that one box is worth 80 tokens whilst the other box is worth 40 tokens. However, in the Suitcase Game we investigate the effect of having such background knowledge by providing participants with AVs on only half of the trials.

Links to the Literature

The Suitcase Game strongly relates to the topic of information asymmetry. A highly influential model in this context was Akerlof's (1970) discussion on the second-hand car market. He posits that there are both bad cars (which we call lemons) and good cars (which we call cherries or peaches). Akerlof makes the assumption that sellers have more information that buyers (i.e. they can assess whether a car is a lemon versus a cherry). Since buyers cannot distinguish between cherries and lemons the rational buyer is assumed to have a willingness to pay (WTP) of only the average market price. However, sellers of cherries do not accept the average price and are hence driven from the market through adverse selection (i.e. only sellers of lemons are happy to sell at the average market price). We provide a schematic illustration of Akerlofs model in which we simplify by assuming that equal amounts of lemons and cherries are present in the market; however even without this simplification the same conclusions are drawn (see Figure 60).

Figure 60: Akerlof's market for lemons

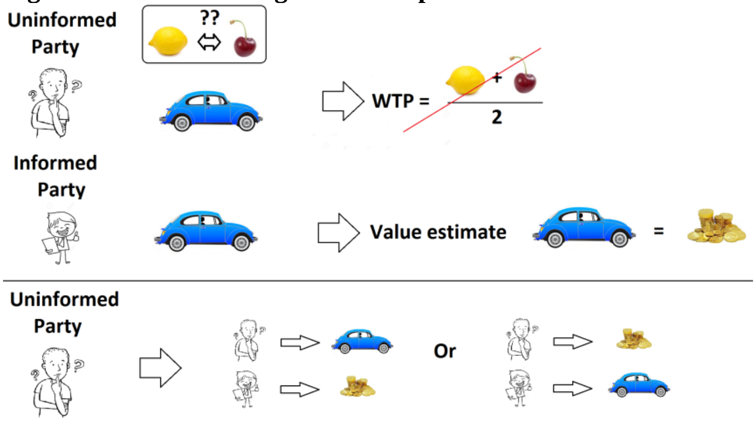


This figure schematically summarizes Akerlof's model.

[55] We remind the reader that the Envelope Game consisted of three envelopes which each had a minimum value of 2 coins and which summed together to a total of 12 coins. One of these three envelopes was destroyed without revealing its content such that participants had some information whilst lacking perfect information.

To illustrate the relevance of the Suitcase Game to the reader we rephrase the game as the Car Game. Image that two people co-own a car (for example, after a divorce or inheritance). One of them is quite knowledgeable about cars and can easily assess its value whilst the other person has no idea what the car is worth. To induce fairness it is decided that the knowledgeable person estimates the resale value of the car and that he offers half of the resale value estimate on the table. The less knowledgeable person then decides whether she rather receives the amount offered on the table (and foregoes her ownership of the car) or whether she rather pays the table amount herself such that she receives full ownership of the car (see Figure 61).

Figure 61: The suitcase game in comparison with Akerlof



This figure illustrates how the Suitcase Game can be framed as a 'Car Game' for comparison with Akerlof's model.

Psychologically, we consider the car game of interest since it can provide intuitions as to why cherries are sold since it does not relate solely to co-owners of goods. When buyers assess whether to buy a specific car they may not always rationally consider the average market price which Akerlof's model suggests; instead they might approach the task by looking at the price of the car and assessing whether they rather have the car by foregoing some of their savings versus whether they rather keep their savings intact by foregoing the car. Furthermore, one can argue that the real life scenarios are not as simple as knowledgeable sellers and uninformed buyers; it is possible that buyers assess the maximum and minimum value of cars similar to the one that can be bought (by researching the make, model, mileage etc.). Assuming that buyers and sellers have the same maximum and minimum values in mind this idea corresponds well with our AVs.

The Car Game is roughly the same as the Suitcase Game setup, with the main difference being that the Car Game can be interpret as having 'costs' (since one "pays" the table amount to receive the car – even though the car is supposedly always worth more than the table amount) whilst the Suitcase Game is framed solely in terms of gains (i.e. either I gain the suitcase amount or I gain the table amount). Furthermore, the suitcase game cannot lead to negative payoffs (i.e. the suitcase contains at worst zero tokens) whilst the car game can theoretically lead to negative payoffs, i.e. if the table amount is larger than the car's resale value estimate.

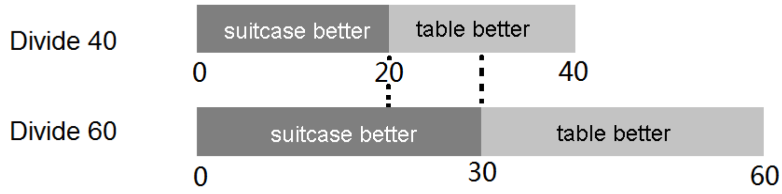
Mathematical notation

In this chapter we occasionally use a mathematical notation for intervals that may be unique for specific countries. Imagine an interval of values situated between X and Y. Depending on the scenario it is possible that X (or Y) lies within the interval but it is also possible that X (or Y) lies outside of the interval. Our notation uses the direction of square brackets to indicate whether the boundaries of the interval lie within the interval. Thus, the notation $[X,Y]$ signifies an interval consisting of values between X and Y, with both X and Y *included* in the interval. Meanwhile, the notation $]X,Y[$ signifies the interval of values between X and Y with both X and Y *excluded* from the interval. The final two notations we may use are $]X,Y]$ and $[X,Y[$ which signify intervals between X and Y in which the former notation includes Y but excludes X whilst the latter notation includes X but excludes Y.

Assumptions and game structure

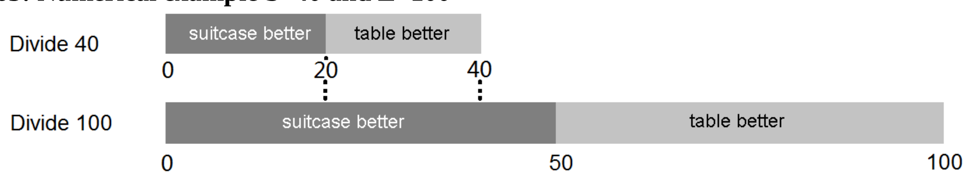
We assume that participants are rational agents who aim to maximize their own pay-off (and thus minimize the pay-off of the other player). Furthermore, we assume that decisions are affected by knowledge of the two announced values (AVs). Concretely, we assume that the choice made by P1 (to whom we refer in this chapter as 'Splitter') is affected both by the distribution amount (DA) and the AVs whilst the choice made by P2 (to whom we refer in this chapter as 'Chooser') is assumably affected both by the AVs and the table amount. Next, we explore the structure of the experimental game. To provide a clear explanation we start off with a numerical example in which the small AV equals 40 tokens whilst the large AV equals 60 tokens (i.e. S=40 and L=60) (see Figure 62).

Figure 62: Numerical example S=40 and L=60



It should be clear from Figure 62 that a rational Splitter cannot place less than 20 tokens on the table (since the Chooser would pick the suitcase due to strong dominance) nor can he place more than 30 tokens on the table (since the Chooser would pick the table due to strong dominance). The Splitter is thus limited to either place exactly 20 or 30 tokens on the table (i.e. scenarios of weak dominance) or to select an amount between 20 and 30 tokens (i.e. scenarios without dominance). We conclude that $\frac{S}{2}$ and $\frac{L}{2}$ are threshold values for dominance and rational Splitters should never place an amount smaller than $\frac{S}{2}$ or larger than $\frac{L}{2}$ on the table. Furthermore, the Splitter should not place $\frac{S}{2}$ on the table when the DA is L nor should he place $\frac{L}{2}$ on the table when the DA is S, since a rational Chooser would pick according to weak dominance in such contexts. It is worthwhile to note that the scenario is slightly more nuanced when the AVs lie further apart (see Figure 63).

Figure 63: Numerical example S=40 and L=100



When the AVs lie far apart it is possible to place an amount on the table between $\frac{S}{2}$ and $\frac{L}{2}$ which is larger than S. Clearly, this allows the Chooser to infer that L has been divided implying that she would always pick the larger chunk if the DA were divided in unequal parts. Using the example from Figure 63 it is possible to place an amount on the table that falls between the thresholds of 20 and 50 tokens which reveals that L has been divided (e.g. 41 tokens cannot be placed on the table when dividing 40 tokens). Thus, a rational Splitter should never place more than S on the table unless he divides into equal segments.

Nash predictions

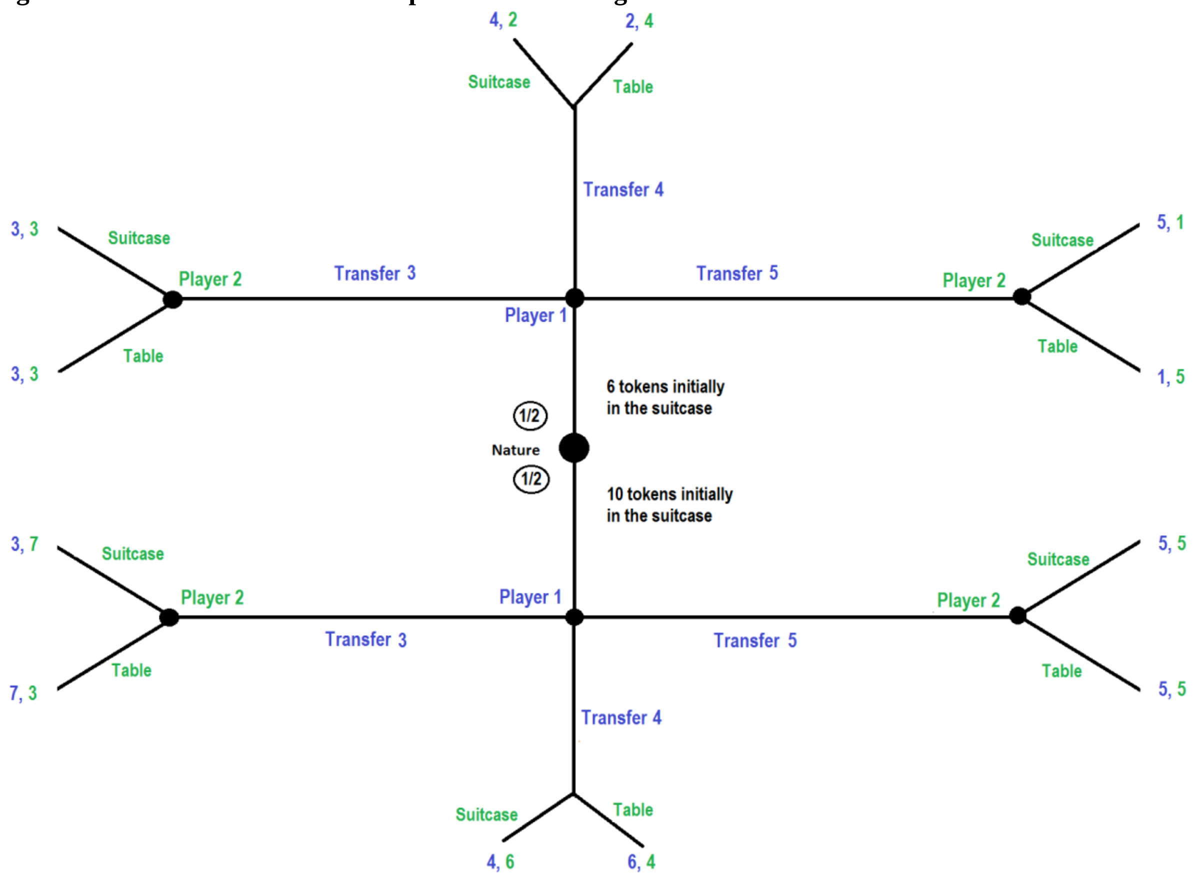
In this section we discuss the Nash predictions for the suitcase game. Given the multitude of possible scenarios we limit our analysis to a more abstract computation using simplified numbers. First, we look at scenarios in which additional values (AVs) are provided since such scenarios lead to a lower bound threshold (i.e. $\frac{S}{2}$) and a higher bound threshold (i.e. $\frac{L}{2}$) for the table amount. When less tokens are placed on the table than the lower bound threshold the suitcase becomes strongly dominant whilst the table becomes strongly dominant if more tokens than the higher bound threshold are placed on the table[56]. Thus, equilibria states can only exist within the interval $\left[\frac{S}{2},\frac{L}{2}\right]$. It is worthwhile to point out that the AVs in our numerical example are close-distanced (i.e. half of the large amount is less than the small amount). Whenever we find a PBNE state we infer whether the same PBNE exists for far distanced amounts by assessing whether the interval $\left]S,\frac{L}{2}\right[$ is part of the equilibrium. Far-distanced AVs cannot be in an equilibrium state when the table amount lies in the interval $\left]S,\frac{L}{2}\right[$ given that P2 would be able to deduce the exact DA in such scenarios (and thus P1 would want to change to a different table amount). This implies that whenever a PBNE state is found for close distanced AVs in which the table amount is not part of the interval $\left]S,\frac{L}{2}\right[$, the same PBNE will exist for scenarios in which the AVs are far distanced. Furthermore, if no

[56] Notice that we already explained this in the 'game structure' of the experiment. We can exclude the idea that less/more tokens would be transferred than the lower/higher bound threshold since this allows P2 to systematically receive the better deal; hence, P1 would want to deviate – i.e. such decisions cannot lead to a PBNE.

PBNE state is found for close distanced AVs then there will never be a PBNE state for far distanced AVs.

We explore potential PBNEs for close-distanced AVs using a simplified example in which the small amount is a DA of six tokens whilst the large amount is a DA of ten tokens (i.e. S=6, L=10) (see Figure 64).

Figure 64: Game tree for PBNE computations involving close values



Note that we speak of the ‘init6’ type when the distribution amount is six tokens whilst we speak of the ‘init10’ type when the distribution amount is ten tokens.

Information sets

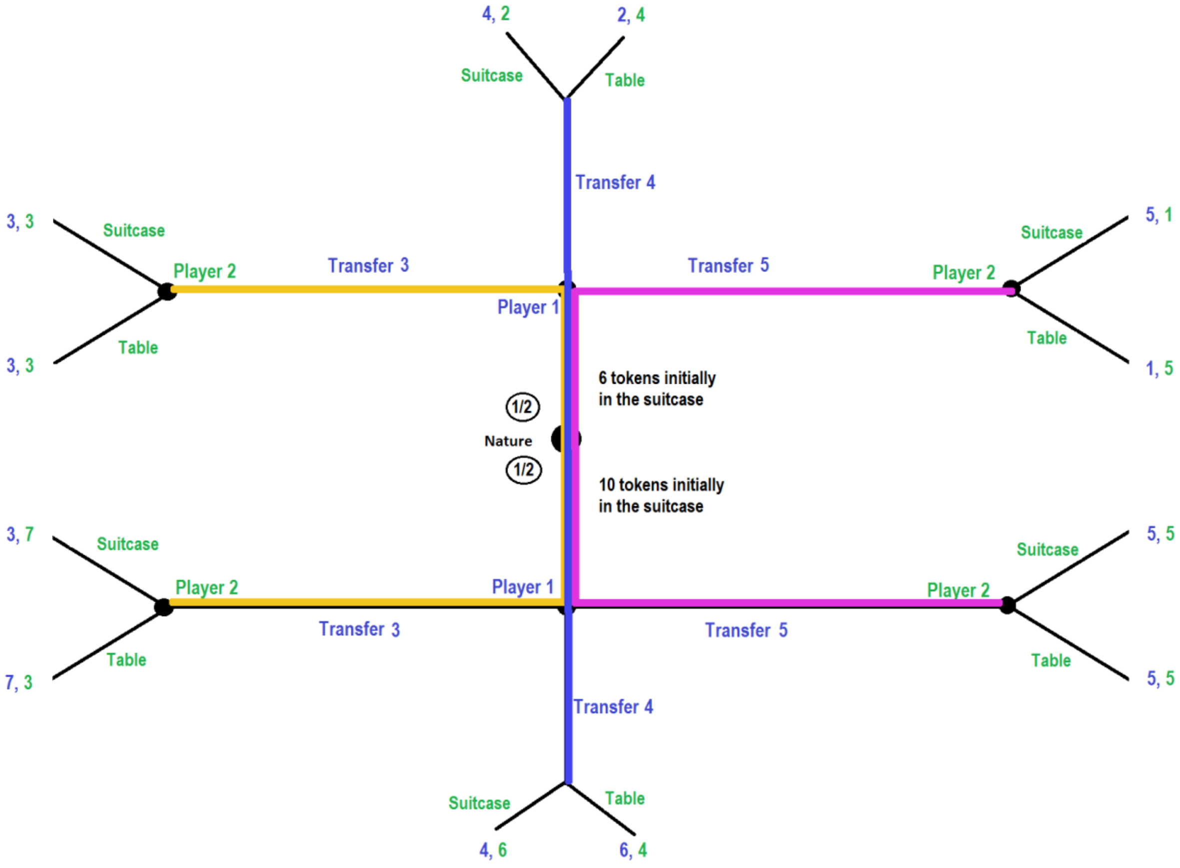
We point out to the reader that our figures in this appendix do not display information sets. A dotted line *should* be present between ‘transfer 3’ decisions for both types; between ‘transfer 4’ decisions for both types and between ‘transfer 5’ decisions for both types[57]. However, the information set for ‘transfer 4’ decisions cannot be added to the figure without cluttering the display; thus we simplified the visual representation of the PBNE calculations by not including these information sets – but they are still present.

Next, we explore potential PBNEs starting with the Pooling PBNEs.

Pooling PBNE

A Pooling Equilibrium requires that the two types (init6 and init10) behave the same way. There are three potential Pooling Equilibria in our example: (a) both types can transfer three tokens; (b) both types can transfer four tokens; or (c) both types can transfer five tokens (see Figure 65).

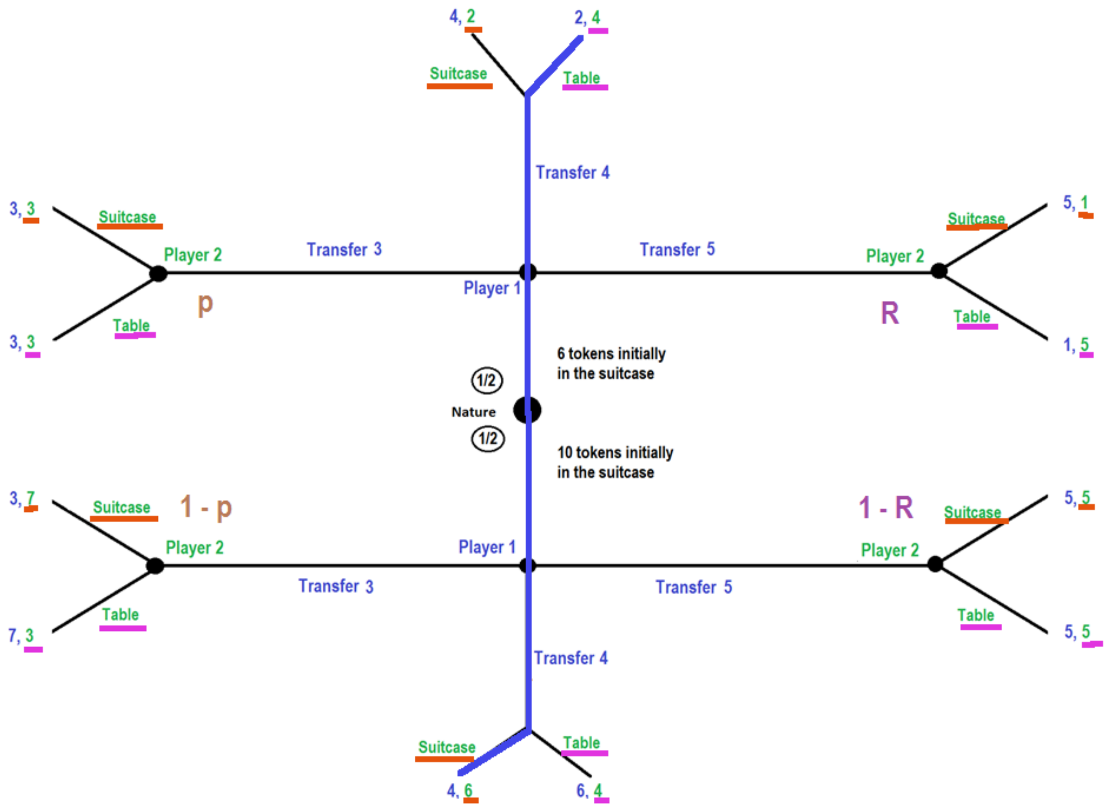
Figure 65: Possible Pooling PBNEs



[57] i.e. P2 does not know which node she is in whenever a transfer of X tokens is made: she may be in the (init6, transfer X) node or she may be in the (init10, transfer X) node.

We can easily deduce that there is no equilibrium possible when both types choose to transfer three tokens (i.e. the orange path) since P2 would choose the suitcase (at least 50% of the time) implying that the 'init10' type wants to deviate and transfer five tokens (i.e. this would offer him an EP of five tokens rather than three tokens). Similarly, there is no equilibrium possible when both types of P1 choose to transfer five tokens (i.e. the purple path) since P2 would choose the table (at least 50% of the time) implying that the 'init5' type wants to deviate and transfer three tokens (i.e. this would offer him an EP of three tokens rather than one token). There is only one possibility left: both types may decide to transfer four tokens (i.e. the blue path); in such a scenario it is not immediately clear to P2 whether the table versus suitcase yields a better pay-off[58]. We explore this possibility more in-depth in Figure 66.

Figure 66: Is there a Pooling PBNE in which both types of P1 transfer four tokens



[58] The same conclusion holds if more than three choices could be made. For example, if 3.5 tokens could be transferred this would not result in a Pooling Equilibrium because P2 has a higher expected payoff (EP) from choosing the suitcase with it being equally likely that P1 made this choice as init6 versus init10 type. Thus, the init10 type would deviate towards transferring four tokens. And if 4.5 tokens could be transferred then the init6 type would deviate. Thus, only the average of the two AVs can be a Pooling PBNE.

First, we observe that P2 is indifferent between the suitcase and the table when four tokens are transferred since $EP_{P2}\left(table \,|\, transfer4\right)$ = $EP_{P2}\left(suitcase \,|\, transfer4\right)$. She can thus choose the table in any probability she likes – we can later restrict this probability to remain in an equilibrium state. Next, we set P2's beliefs such that she becomes indifferent (between choosing the table and the suitcase) when three or five tokens are transferred (i.e. the off-equilibria paths). When three tokens are transferred P2's belief is such that P1 must be the 'init6' type ($p=1$) (see Equation 38).

Equation 38: Setting P2s beliefs (p)

$$EP_{P2}(suitcase \,|\, transfer3) = 3p + 7(1-p)$$

$$EP_{P2}(table \,|\, transfer3) = 3p + 3(1-p)$$

$$EP_{P2}(suitcase \,|\, transfer3) = EP_{P2}(table \,|\, transfer3) \Leftrightarrow 3p + 7(1-p) = 3p + 3(1-p)$$
$$\Leftrightarrow 7(1-p) = 3(1-p) \Leftrightarrow 7 - 7p = 3 - 3p \Leftrightarrow 4 = 4p \Leftrightarrow 1 = p$$

If she believes there is even the slightest chance of being in the 'init10' node she would pick the suitcase (instead of being indifferent). When five tokens are transferred P2's belief is such that P1 must be the 'init10' type ($r=0$) (see Equation 39).

Equation 39: Setting P2s beliefs (r)

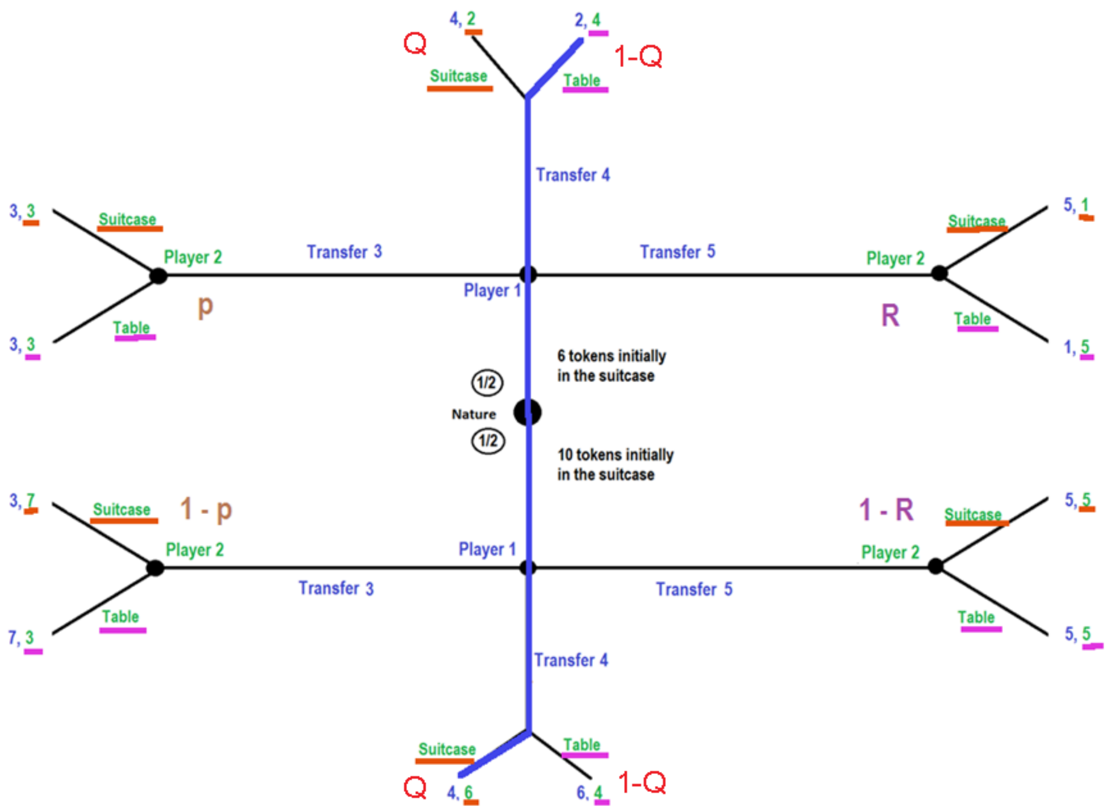
$$EP_{P2}(suitcase \,|\, transfer5) = 1r + 5(1-r)$$

$$EP_{P2}(table \,|\, transfer5) = 5r + 5(1-r)$$

$$EP_{P2}(suitcase \,|\, transfer5) = EP_{P2}(table \,|\, transfer5) \Leftrightarrow 1r + 5(1-r) = 5r + 5(1-r) \Leftrightarrow$$
$$1r = 5r \Leftrightarrow 0 = 4r \Leftrightarrow 0 = r$$

If she beliefs that there is even the slightest chance of being in the 'init6' node she would pick the table (instead of being indifferent). To ensure that this is an equilibrium state we need to set a probability (Q) for P2 to pick the suitcase when four tokens are transferred such that P1 has no desire to deviate from the equilibrium path (see Figure 67 and Equation 40).

Figure 67: Setting the value for Q such that P1 does not desire to deviate



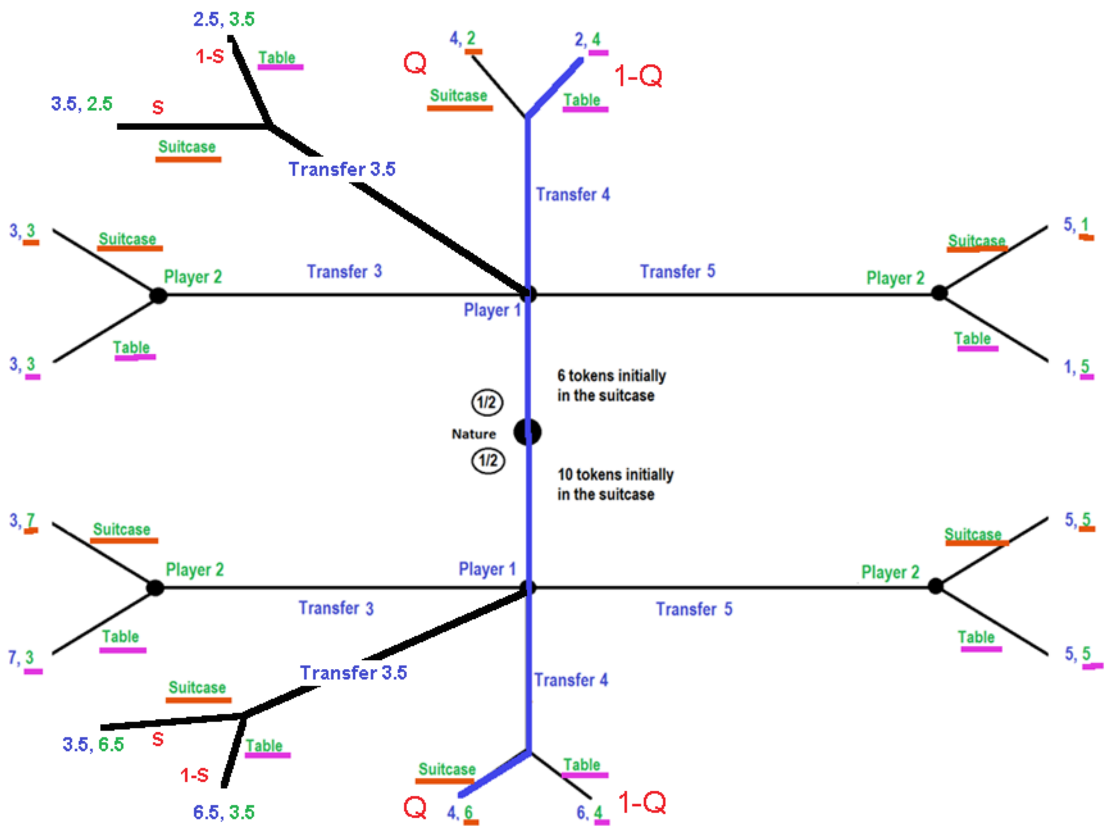
Equation 40: Setting the value for Q such that P1 would be indifferent

$$EP_{P1}(transfer3) \le EP_{P1}(transfer4) \quad \Leftrightarrow 3 \le 4Q + 2(1-Q) \quad \Leftrightarrow 3 \le 2Q + 2 \quad \Leftrightarrow 1 \le 2Q \quad \Leftrightarrow \frac{1}{2} \le Q$$

$$EP_{P1}(transfer5) \le EP_{P1}(transfer4) \quad \Leftrightarrow 5 \le 4Q + 6(1-Q) \quad \Leftrightarrow 5 \le -2Q + 6 \quad \Leftrightarrow 2Q \le 1 \quad \Leftrightarrow Q \le \frac{1}{2}$$

This means that P2 has to pick the table exactly 50% of the time when four tokens are transferred to prevent P1 from deviating towards transferring three or five tokens. However, we should also consider what would happen if P1 could make transfers such as 3.5 tokens (i.e. scenarios between the currently assessed cases typically exist and may change the picture). This possibility would involve its own beliefs for P2 and the probability of P2 picking the suitcase if a 3.5 transfer is made needs to be set such that P1 does not desire to deviate from the suggested equilibrium state (see Figure 68 and Equation 41).

Figure 68: What happens if a transfer of 3.5 tokens can be made



Equation 41: Computing P2s beliefs (p') if 3.5 tokens are transferred

$$EP_{P2}(suitcase \mid transfer3.5) = 3.5p' + 3.5(1-p')$$

$$EP_{P2}(table \mid transfer3.5) = 2.5p' + 6.5(1-p')$$

$$EP_{P2}(suitcase \mid transfer3.5) = EP_{P2}(table \mid transfer3.5) \Leftrightarrow 3.5p' + 3.5(1-p') = 2.5p' + 6.5(1-p') \Leftrightarrow 3.5 = -4.5p' + 6.5 \Leftrightarrow -3 = -4.5p' \Leftrightarrow p' = \frac{6}{9} \Leftrightarrow p' = \frac{2}{3}$$

We skip the computation of the parameter ‘R’ due to its symmetric nature; and assess whether we can set the probability Q (i.e. the same Q as we set before to equal 50%) such that P1 is indifferent between transferring 3.5 tokens versus transferring 4 tokens. Note, that the EP of a 3.5 token transfer also requires a probability parameter (since the table and suitcase now have different values).

Equation 42: Setting parameter values such that P1 does not desire to deviate

$$EP_{P1}(transfer3.5 \mid init6) \le EP_{P1}(transfer4 \mid init6) \Leftrightarrow 3.5S + 2.5(1-S) \le 4Q + 2(1-Q)$$

$$\Leftrightarrow S + 2.5 \le 2Q + 2 \Leftrightarrow S + 0.5 \le 2Q \Leftrightarrow \frac{S+0.5}{2} \le Q$$

$$EP_{P1}(transfer3.5 \mid init10) \leq EP_{P1}(transfer4 \mid init10)$$
$$\Leftrightarrow 3.5S + 6.5(1-S) \leq 4Q + 6(1-Q) \qquad \Leftrightarrow -3S + 6.5 \leq -2Q + 6 \quad \Leftrightarrow -3S + 0.5 \leq -2Q$$
$$\Leftrightarrow \frac{3S - 0.5}{2} \geq Q$$

Since we already set the value of Q earlier to be 50%, this means that the parameter S needs to be set as $S \leq 0.5$ and $S \geq 0.5$. Thus, if a transfer is made between three and four (or between four and five) tokens P2 should pick randomly such that P1 has no incentive to deviate. Concretely, the init6 type would transfer 3.5 tokens if P2 were more likely to pick the suitcase whilst the init10 type would transfer 3.5 tokens if P2 were more likely to pick the table. Thus, we conclude that parameters can be set such that P1 does not desire to deviate even when additional 'in between' scenarios are possible strategies[59].

In essence, there is a Pooling PBNE in which P1 always transfers four tokens whilst P2 picks the suitcase exactly half the time when four token transfers are made. P2 picks the suitcase at least 50% of the time if three tokens are transferred whilst she picks the table at least 50% of the time if five tokens are transferred. Furthermore, if an amount between three and five tokens is transferred P2 picks the suitcase exactly 50% of the time (to prevent P1 from deviating with either of his types). We stress for the reader that a Pooling PBNE does not exists for any other amount between three and five tokens since P2 would then have a clear preference (i.e. a preference for the table if 4.5 tokens are placed on the table without regards to the distribution amount being small versus large; and a preference for the suitcase if 3.5 tokens are placed on the table without regards to the distribution amount). The only Pooling PBNE possible is when exactly 4 tokens are placed on the table since this makes P2 indifferent between the table and suitcase.

For far AVs the same Pooling PBNEs exist since half of the average AV for far values is consistently smaller than S (implying that same conclusions hold as for close values). This is proven in Equation 43.

[59] We did this additional part with 'in between' scenarios to illustrate that the same results are found in cases where more complex numbers are used. This excursion is irrelevant for the separating PBNEs that we discuss later on given that those already have an 'in between' scenario exemplified (i.e. transfer four); but it seems worthwhile to add it in for Pooling PBNEs due to their lack of in between scenarios in our simplified example.

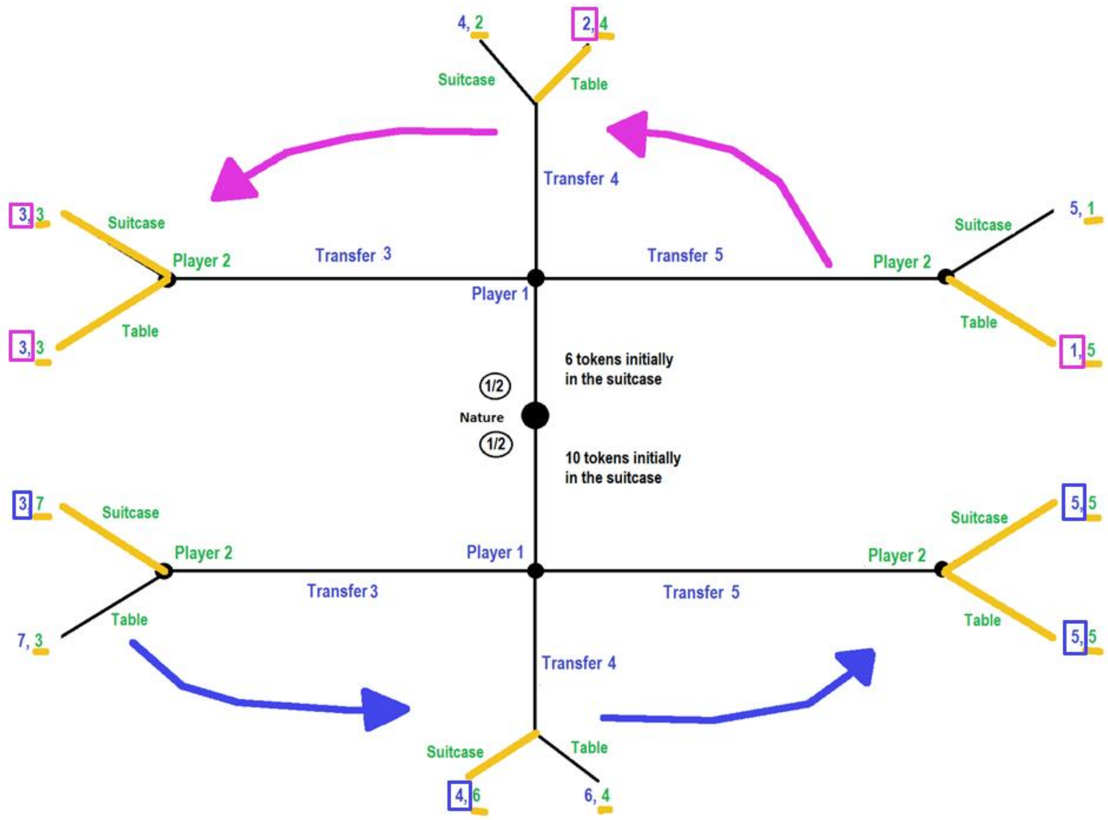
Equation 43: Proof that half the average AV for small values is smaller than S

If the small AV is S then the large AV for values is $\frac{5S}{2}$; thus the average AV value is $\frac{S+\frac{5S}{2}}{2}=\frac{\frac{2S+5S}{2}}{2}=\frac{2S+5S}{4}=\frac{7S}{4}$. Thus, half of the average AV value is by definition smaller than S, since $\frac{\frac{7S}{4}}{2}=\frac{7S}{8}<S$.

Separating PBNE

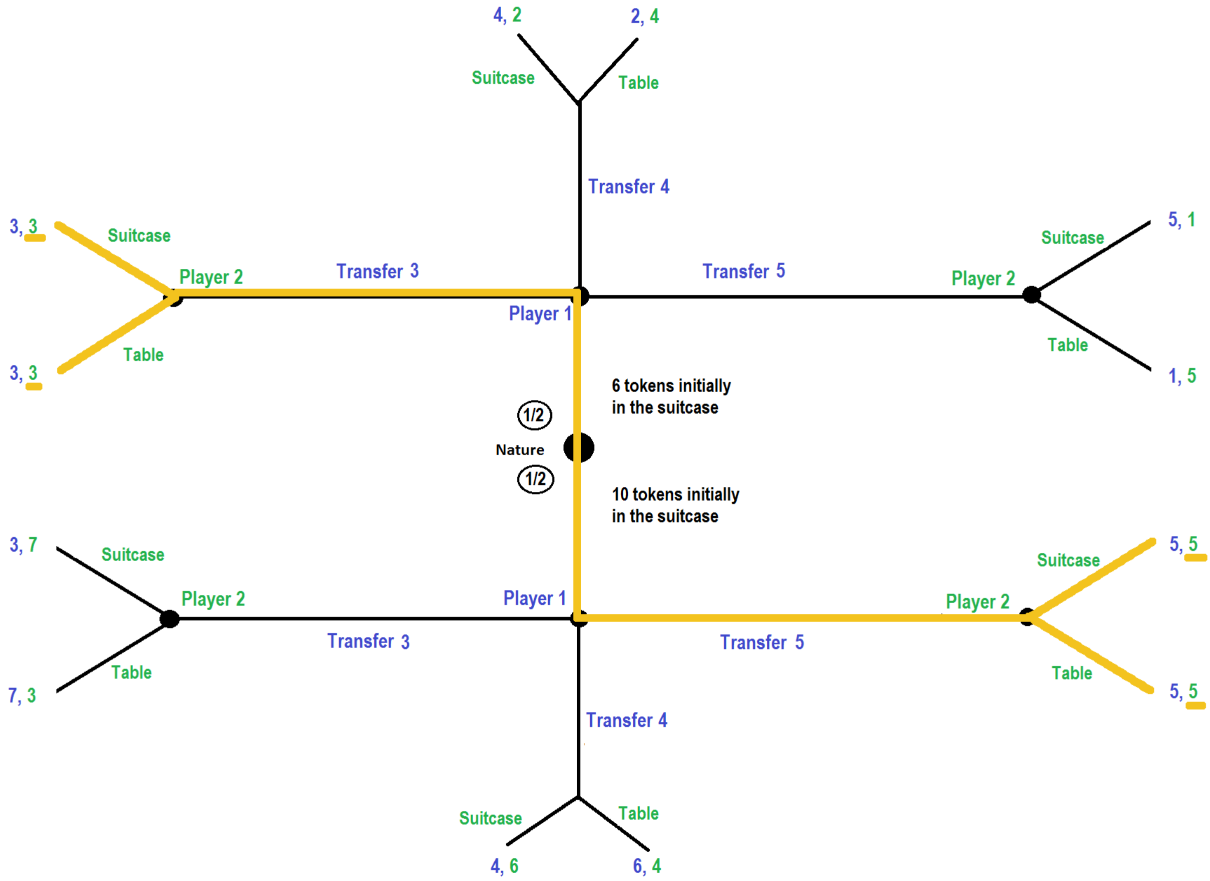
Separating Equilibria are those in which P1 makes a different choice if his type is init6 versus init10. The result is that P2 can deduce P1's type based on his actions. We assess whether a Separating PBNE is possible for close amounts (see Figure 69).

Figure 69: Assessing whether a separating PBNE possible for close amounts



P2's preferences for each of the possible nodes are illustrated in orange. Based on these preferences we can assess when P1 would deviate in each of his types. The purple arrows show how P1 wants to deviate as 'init6' type from transferring five or four tokens to transferring three tokens. The blue arrows show how P1 wants to deviate as 'init10' type from transferring three or four tokens to transferring five tokens. From this we conclude that the only possible Separating PBNE is to transfer three tokens as 'init6' type and to transfer five tokens as 'init10' type. In Figure 70 we assess whether such equilibrium can exist.

Figure 70: Is a Separating PBNE possible for close values



If this is an equilibrium-state then P2 is indifferent between the table and the suitcase. After all, her EP is the same regardless her choice since only the 'init10' type transfers five tokens whilst only the 'init6' type transfers three tokens. However, to be in this equilibrium state her choices need to be such that P1 has no incentive to deviate. Concretely, if she always picks 'table' when five tokens are transferred whilst picking 'suitcase' when three tokens are transferred P1 has no incentive to deviate and an equilibrium-state would be reached. However, even when

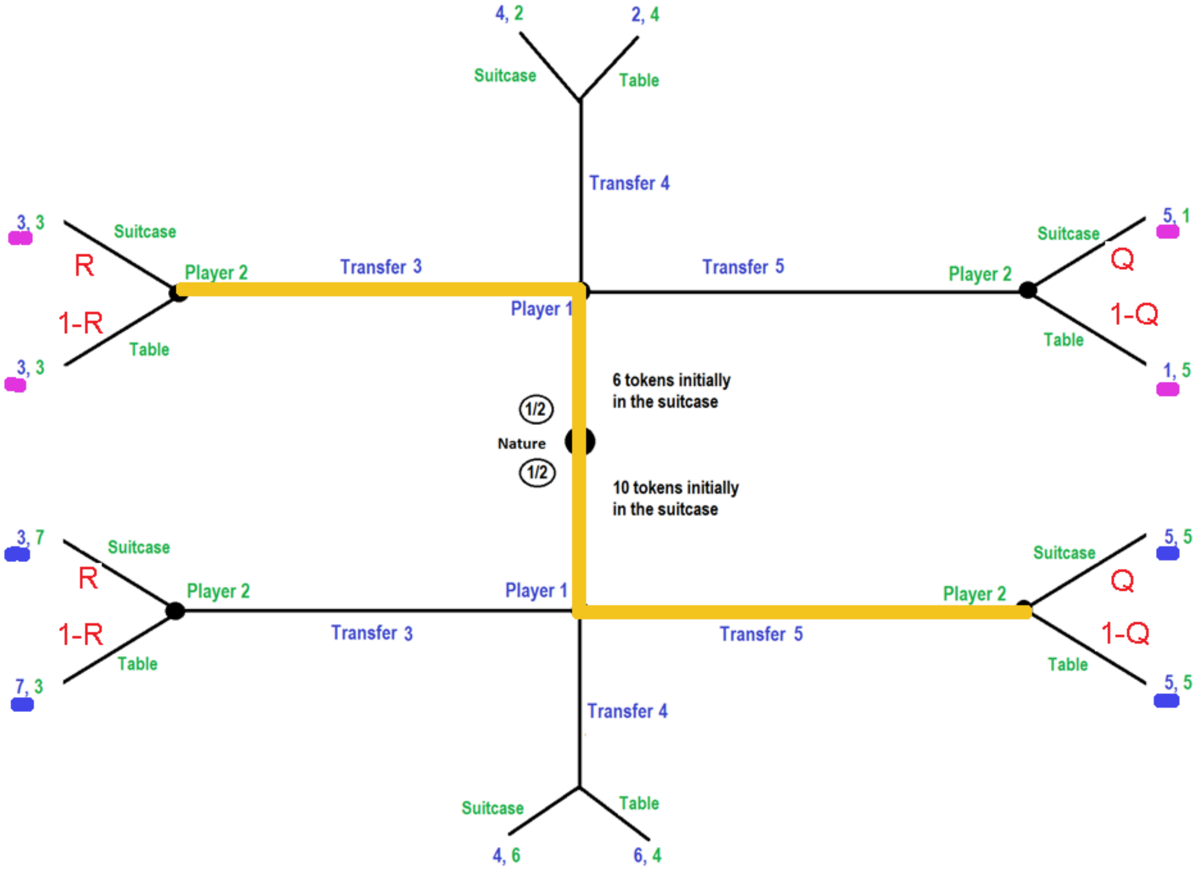
P2 uses a mixed strategy the probabilities can be set such that P1 does not desire to deviate (see Equation 44 and Figure 71).

Equation 44: Setting the probabilities for P2's decisions such that P1 does not want to deviate from the equilibrium path

$$EP_{P1}\left(transfer3 \,|\, init10\right) \leq EP_{P1}\left(transfer5 \,|\, init10\right)$$

$$EP_{P1}\left(transfer5 \,|\, init6\right) \leq EP_{P1}\left(transfer3 \,|\, init6\right)$$

Figure 71: Setting the probabilities Q and R such that P1 does not want to deviate



To prevent P1 from deviating we set $Q \leq \frac{1}{2}$ and $R \geq \frac{1}{2}$ (see Equation 45).

Equation 45: Setting the values for Q and R

$$5Q + 1(1-Q) \leq 3 \Leftrightarrow 5Q + 1 - Q \leq 3 \Leftrightarrow 4Q \leq 2 \Leftrightarrow Q \leq \frac{1}{2}$$

$$3R + 7(1-R) \leq 5 \;\Leftrightarrow 3R + 7 - 7R \leq 5 \Leftrightarrow -4R \leq -2 \Leftrightarrow R \geq \frac{-2}{-4} \Leftrightarrow R \geq \frac{1}{2}.$$

Thus, as long as P2 picks the table at least 50% of the time when five tokens are transferred whilst picking the suitcase at least 50% of the time when three tokens are transferred she ensures that P1 has no desire to deviate from the equilibrium state (since deviating would decrease his EP).

In conclusion, there is a Separating PBNE in which P1 aims to equalize the table and suitcase value whilst P2 picks the table (at least 50% of the time) when it contains five tokens (i.e. half of the large amount's value) whilst she picks the suitcase (at least 50% of the time) when the table contains three tokens (i.e. half of the small amount's value). Since the equilibrium does not involve values from the $\left]S, \frac{L}{2}\right[$ interval it remains an equilibrium state when the AVs are 'far' distanced.

Semi-Separating PBNE

We speak of a Semi-Separating PBNE when one type uses a mixed strategy whilst the other type uses a pure strategy. From our previous discussions it should be obvious that there cannot be an equilibrium state in which both types consider the strategy of transferring three tokens (i.e. the init10 type would deviate) nor can there be an equilibrium state in which both types consider the strategy of transferring five tokens (i.e. the init6 type would deviate). Thus, we are left with five possible Semi-Separating PBNEs as is summarized in Table 50.

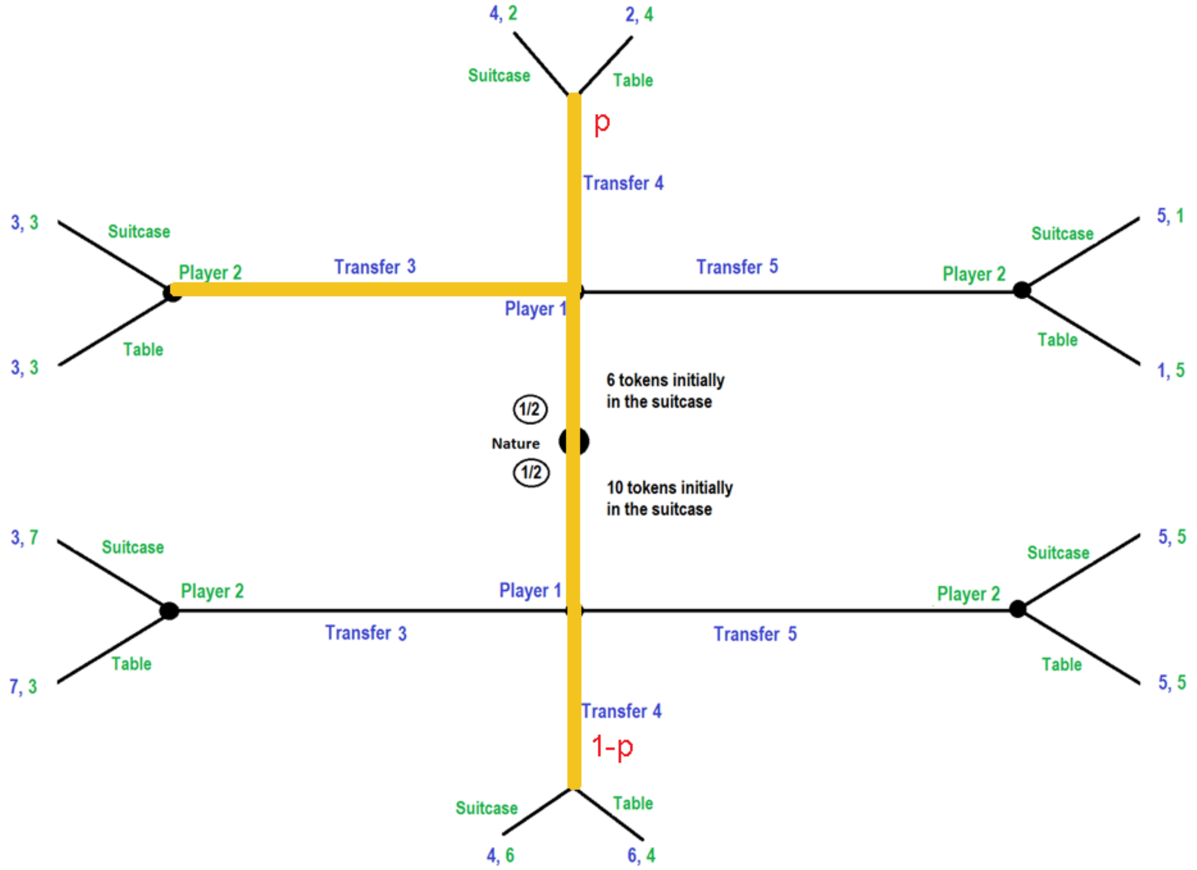
Table 50: Possible semi-separating PBNEs

	Type init6	Type init10
Type init6 mixes	Transfer three or transfer four	Transfer four
	Transfer three or transfer four	Transfer five
Type init10 mixes	Transfer three	Transfer four or transfer five
	Transfer four	Transfer four or transfer five
Both types mix	Transfer three or transfer four	Transfer four or transfer five

However, it does not take much imagination to further exclude two of these mixtures as they cannot be equilibrium states. If type 'init6' mixes between transferring three and four tokens whilst type 'init10' transfers five tokens then P2 can deduce her opponents type from their decision. Thus, the 'init6' type would rather transfer three tokens (and receive three tokens as pay-off) than transferring four tokens (and receiving only two tokens as his pay-off). Similarly, there is no equilibrium possible in which the 'init10' type transfers four or five tokens whilst the 'init6' type transfers three tokens for the same reasons (i.e. P2 would deduce P1's type and thus the 'init10' type rather transfers five tokens than using a mixed strategy). Thus, we only need to consider scenarios in which both types transfer four tokens.

We first discuss the scenario in which the 'init6' type mixes whilst the 'init10' type does not mix. Given the symmetry with the scenario in which the 'init10' type mixes whilst the init6' type does not mix we only discuss one of these scenarios and generalize the outcome.

Figure 72: Exploring whether a semi-separating PBNE exists in which the 'init6' type mixes between transferring three and four tokens whilst 'init10' always transfers five tokens



For this to be a Semi-Separating PBNE we need to set P2's belief ('p') such that she is indifferent between choosing the table versus suitcase when four tokens are transferred. This requires a belief $p = 0.5$ (see Equation 46).

Equation 46: Computing P2's belief

$$EP_{P2}\left(suitcase \mid transfer4\right) = 2p + 6(1-p)$$

$$EP_{P2}\left(table \mid transfer4\right) = 4p + 4(1-p)$$

$$EP_{P2}\left(suitcase \mid transfer4\right) = EP_{P2}\left(table \mid transfer4\right) \Leftrightarrow 2p + 6(1-p) = 4p + 4(1-p)$$
$$\Leftrightarrow 2(1-p) = 2p \Leftrightarrow 1-p = p \Leftrightarrow p = \frac{1}{2}$$

Next, we compute which mixed strategy P1 should use for the equilibrium state to exist. We use Bayes' rule (see Equation 47).

Equation 47: Computing P1s mixed strategy

$$p = \frac{1}{2} = \frac{prob_{init10} \times prob_{transfer4|init10}}{prob_{init10} \times prob_{transfer4|init10} + prob_{init6} \times prob_{transfer4|init6}}$$

$$\Leftrightarrow \frac{1}{2} = \frac{\frac{1}{2} \times 1}{\frac{1}{2} \times 1 + \frac{1}{2} \times prob_{transfer4|init6}} \Leftrightarrow \frac{1}{2} = \frac{\frac{1}{2} \times 1}{\frac{1}{2} \times 1 + \frac{1}{2} \times prob_{transfer4|init6}}$$

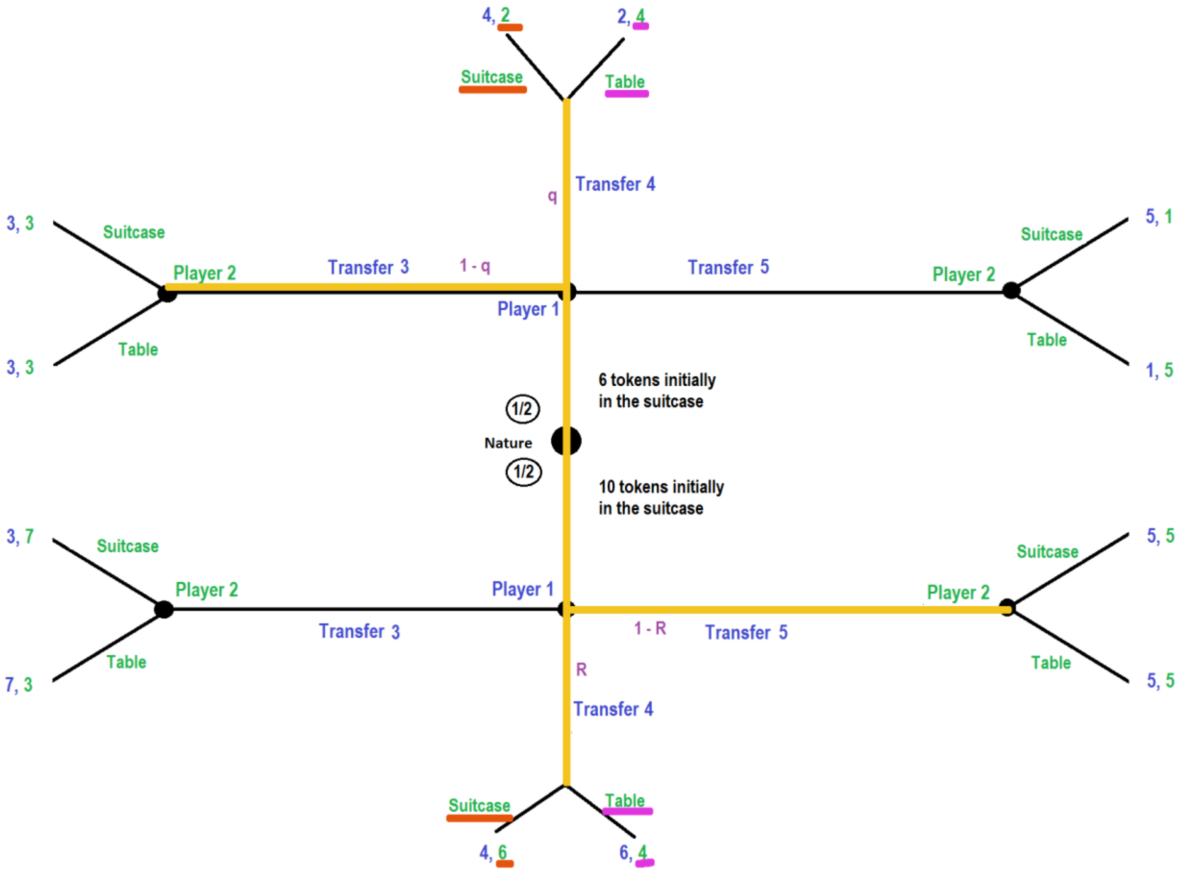
$$\Leftrightarrow \frac{1}{2} = \frac{\frac{1}{2} \times 1}{\frac{1}{2} \times 1 + \frac{1}{2} \times prob_{transfer4|init6}} \Leftrightarrow \frac{1}{2}\left(\frac{1}{2} \times 1 + \frac{1}{2} \times prob_{transfer4|init6}\right) = \frac{1}{2} \times 1$$

$$\Leftrightarrow \frac{1}{2} \times 1 + \frac{1}{2} \times prob_{transfer4|init6} = 1 \Leftrightarrow \frac{1}{2} \times prob_{transfer4|init6} = \frac{1}{2} \Leftrightarrow prob_{transfer4|init6} = 1$$

This does not lead to a Semi-Separating PBNE of the desired structure since the init6 type would transfer four tokens with probability 'one' instead of using a mixed strategy. There cannot be a Semi-Separating PBNE either in which the init10 type mixes between transferring four versus five tokens whilst the init6 type transfers four tokens since the init10 type would then transfer four tokens with probability 'one' (i.e. symmetrical to the scenario that was just discussed).

A final Semi-Separating PBNE that can exist is when both types mix between equalizing and transferring four tokens (see Figure 73).

Figure 73: Exploring a fully mixed PBNE



For this to be a Semi-Separating PBNE P2 needs to be indifferent between the suitcase and the table regardless whether three, four or five tokens are transferred. When three tokens are transferred P2 knows to be in the 'init6, transfer 3' node in which she is indifferent between the table and suitcase (she would pick the suitcase at least 50% of the time to prevent P1 from deviating); similarly, when five tokens are transferred P2 knows to be in the 'init10, transfer 5' node in which she is also indifferent between the table and suitcase (she would pick the table at least 50% of the time to prevent P1 from deviating). Finally, when four tokens are transferred we compute EP_{P2} when she chooses the table versus the suitcase and set the parameters such that she is indifferent between them (see Equation 48).

Equation 48: Setting Q and R such that P2 is indifferent when four tokens are transferred

$$prob_{6initially|transfer\,4} = \frac{prob_{6initially} * prob_{transfer\,4|6initially}}{prob_{6initially} * prob_{transfer\,4|6initially} + prob_{10initially} * prob_{transfer\,4|10initially}}$$

$$= \frac{\frac{1}{2}*Q}{\frac{1}{2}*Q+\frac{1}{2}*R} = \frac{Q}{Q+R}$$

$$EP_{P2}\left(suitcase \mid transfer4\right) = 2\frac{Q}{Q+R}+6\left(1-\frac{Q}{Q+R}\right)$$

$$EP_{P2}\left(table \mid transfer4\right) = 4\frac{Q}{Q+R}+4\left(1-\frac{Q}{Q+R}\right)$$

P2 is indifferent if: $2\frac{Q}{Q+R}+6\left(1-\frac{Q}{Q+R}\right)=4\frac{Q}{Q+R}+4\left(1-\frac{Q}{Q+R}\right)$

$$\Leftrightarrow 2\left(1-\frac{Q}{Q+R}\right)=2\frac{Q}{Q+R} \Leftrightarrow 1-\frac{Q}{Q+R}=\frac{Q}{Q+R} \Leftrightarrow 1=2\frac{Q}{Q+R} \Leftrightarrow \frac{1}{2}(Q+R)=Q$$
$$\Leftrightarrow \frac{1}{2}R=\frac{1}{2}Q \Leftrightarrow R=Q$$

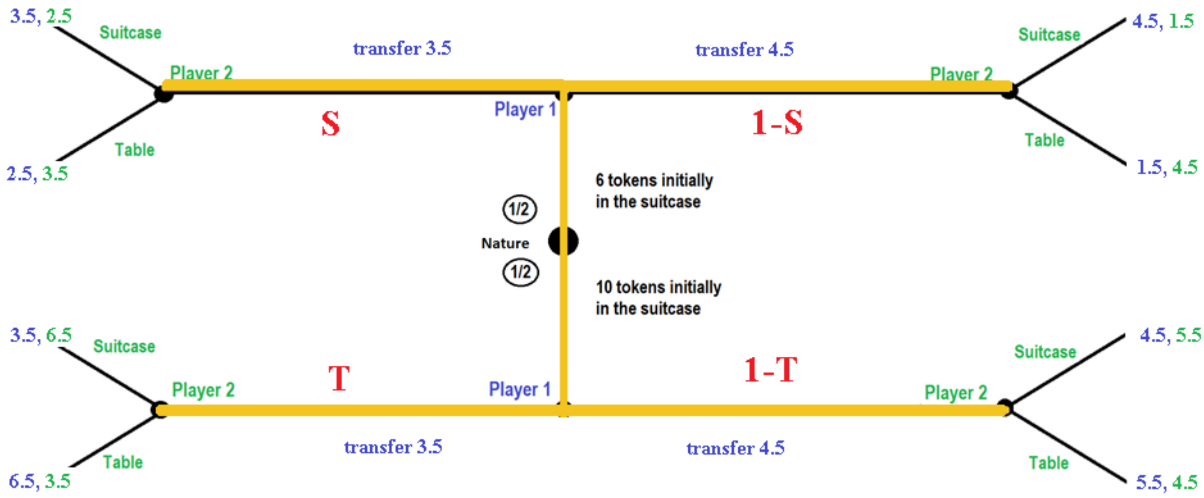
Thus, we conclude that there is a Semi-Separating PBNE as long as the probability of the ‘init6’ type making a four tokens transfer equals the probability of the ‘init10’ type making a four token transfer ($R=Q$). P1 cannot gain from deviating and thus we have a PBNE. Again, we stress for the reader that this equilibrium structure does not exist for any other amounts between three and five tokens that is shared between the two types of P1 since P2 would not pick the table exactly 50% of the time for any other amounts.

Finally, the same Semi-Separating PBNE exists if far distanced AVs are used as long as the two types avoid the interval $\left]S,\frac{L}{2}\right[$ (i.e. in this interval P2 can deduce that the large amount is divided and hence she can pick the larger value).

Fully Mixed PBNE

We speak of a Fully Mixed PBNE if both types of P1 use the same mixed strategy. The only Fully Mixed PBNE that we cannot immediately reject is one in which both types mix between transferring amounts from the interval $\left]\frac{S}{2},\frac{L}{2}\right[$. We thus explore whether a Fully Mixed PBNE can exist in which P1 uses only two strategies: either he transfer 3.5 tokens or he transfers 4.5 tokens. These strategies are equidistant from half of the average AV and thus have the most likelihood of generating equilibrium. Since we only discuss two potential strategies we use a simplified representation of the game structure which solely looks at those two strategies.

Figure 74: Assessing Fully Mixed PBNEs



Equation 49: Bayes' rule to compute parameter values such that the PBNE can exist

$$prob_{init6|transfer3.5}\frac{prob_{init6}\times prob_{transfer3.5|init6}}{prob_{init6}\times prob_{transfer3.5|init6}+prob_{init10}\times prob_{transfer3.5|init10}}$$

$$=\frac{\frac{1}{2}\times S}{\frac{1}{2}\times S+\frac{1}{2}\times T}=\frac{S}{S+T}$$

$$EP_{P2}(table\,|\,transfer3.5)=3.5\frac{S}{S+T}+3.5(1-\frac{S}{S+T})$$

$$EP_{P2}(suitcase\,|\,transfer3.5)=2.5\frac{S}{S+T}+6.5(1-\frac{S}{S+T})$$

To be indifferent between the table and the suitcase when 3.5 tokens are transferred the parameters need to have the following relationship (see Equation 50):

Equation 50: Making P2 indifferent when transfer 3.5

$$3.5\frac{S}{S+T}+3.5(1-\frac{S}{S+T})=2.5\frac{S}{S+T}+6.5(1-\frac{S}{S+T})$$
$$\Leftrightarrow 3.5\frac{S}{S+T}+3.5-3.5\frac{S}{S+T}=2.5\frac{S}{S+T}+6.5-6.5\frac{S}{S+T}$$

$$\Leftrightarrow 3.5=+6.5-4\frac{S}{S+T}\Leftrightarrow -3=-4\frac{S}{S+T}\Leftrightarrow 3(S+T)=4S\Leftrightarrow 3S+3T=4S\Leftrightarrow 3T=S$$

To also be indifferent between the table and the suitcase when 4.5 tokens are transferred the parameters also need to have the following relationship[60]:

Equation 51: Making P2 indifferent when transfer 4.5

$$EP_{P2}(table\,|\,transfer4.5)=4.5(1-\frac{S}{S+T})+4.5\frac{S}{S+T}$$

$$EP_{P2}(suitcase\,|\,transfer4.5)=1.5(1-\frac{S}{S+T})+5.5\frac{S}{S+T}$$

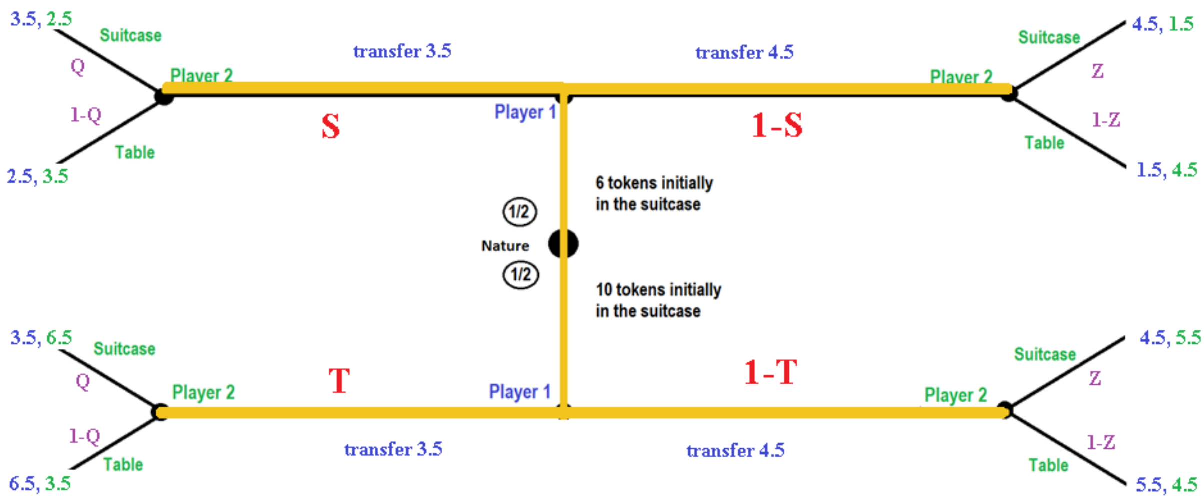
$$4.5(1-\frac{S}{S+T})+4.5\frac{S}{S+T}=1.5(1-\frac{S}{S+T})+5.5\frac{S}{S+T}$$
$$\Leftrightarrow 4.5-4.5\frac{S}{S+T}+4.5\frac{S}{S+T}=5.5\frac{S}{S+T}+1.5-1.5\frac{S}{S+T}$$

$$\Leftrightarrow 4.5=1.5+4\frac{S}{S+T}\Leftrightarrow 3=4\frac{S}{S+T}\Leftrightarrow 3(S+T)=4S\Leftrightarrow 3S+3T=4S\Leftrightarrow 3T=S$$

Thus, we potentially have a Fully Mixed PBNE in which both 3.5 and 4.5 transfers are made (both by the init6 and init10 player) as long as the probability of the init6 player making a 3.5 transfer is three times smaller than the probability of the init10 player making such a transfer. Similarly, the probability of the init6-player making the 4.5 transfer should be three times larger than the probability of the init10 player making such a transfer. To ascertain whether this state is a plausible equilibrium we need to set P2's decision probability such that P1 has no incentive to deviate from the equilibrium. We set the probability of P2 selecting the suitcase when 3.5 tokens are transferred as Q whilst we set the probability of selecting the suitcase when 4.5 tokens are transferred as Z (see Figure 75).

60 Note that the probability of a 3.5 transfer being made by the init6-player is set as $\frac{S}{S+T}$; since the suggested equilibrium has only 3.5 and 4.5 transfers as possibilities this means that the probability of a 4.5 transfer being made by init6 has to equal $1-\frac{S}{S+T}$; hence, even though it may seem like we swap which variable is multiplied by which parameter it is simply because the parameters need to sum to 'one'.

Figure 75: Setting Q and Z such that P1 does not desire to deviate



Equation 52: Setting Q and Z parameters such that init6 does not desire to deviate

$$P_{P1}(init6 \mid transfer3.5) = 3.5Q + 2.5(1-Q)$$

$$EP_{P1}(init6 \mid transfer4.5) = 4.5Z + 1.5(1-Z)$$

P1 is indifferent as init6 if: $3.5Q + 2.5(1-Q) = 4.5Z + 1.5(1-Z)$

$$\Leftrightarrow 3.5Q + 2.5 - 2.5Q = 4.5Z + 1.5 - 1.5Z \Leftrightarrow 1Q + 2.5 = 3Z + 1.5$$

$$\Leftrightarrow Q + 1 = 3Z \Leftrightarrow Q = 3Z - 1$$

Equation 53: Setting Q and Z parameters such that init10 does not desire to deviate

$$EP_{P1}(init10 \mid transfer3.5) = 3.5Q + 6.5(1-Q)$$

$$EP_{P1}(init10 \mid transfer4.5) = 4.5Z + 5.5(1-Z)$$

P1 is indifferent as init10 if: $3.5Q + 6.5(1-Q) = 4.5Z + 5.5(1-Z)$

$$\Leftrightarrow 3.5Q + 6.5 - 6.5Q = 4.5Z + 5.5 - 5.5Z$$

$$\Leftrightarrow -3Q + 6.5 = -Z + 5.5 \Leftrightarrow -3Q + 1 = -Z \Leftrightarrow -3Q = -Z - 1 \Leftrightarrow 3Q = Z + 1 \Leftrightarrow Q = \frac{Z+1}{3}$$

To have a Fully Mixed PBNE we need to satisfy $Q = 3Z - 1$ and $Q = \frac{Z+1}{3}$, thus:

Equation 54: Setting Q and Z such that both init6 and init10 are indifferent between 3.5 and 4.5 transfers

$$\begin{cases} Q = \frac{Z+1}{3} \\ Q = 3Z-1 \end{cases} \begin{cases} 3Z-1 = \frac{Z+1}{3} \\ Q = 3Z-1 \end{cases} \begin{cases} 3(3Z-1) = Z+1 \\ Q = 3Z-1 \end{cases} \begin{cases} 9Z-3 = Z+1 \\ Q = 3Z-1 \end{cases} \begin{cases} 8Z = 4 \\ Q = 3Z-1 \end{cases} \begin{cases} Z = \frac{1}{2} \\ Q = 3Z-1 \end{cases}$$

$$\begin{cases} Z = \frac{1}{2} \\ Q = 3Z-1 \end{cases} \begin{cases} Z = \frac{1}{2} \\ Q = 3\frac{1}{2}-1 \end{cases} \begin{cases} Z = \frac{1}{2} \\ Q = \frac{3}{2}-\frac{2}{2} \end{cases} \begin{cases} Z = \frac{1}{2} \\ Q = \frac{1}{2} \end{cases}$$

In conclusion, we find a Fully Mixed PBNE in which the init6 and init10 type use the same two strategies which are equidistant from half of the average AV. P2 is indifferent since P1 uses a mixed strategy that does not allow her to gain from a consistent bias towards the table or suitcase; and P1 is indifferent since P2 uses a mixed strategy in which she picks the table and suitcase equally often regardless whether the 3.5 or the 4.5 transfer is made, since this does not allow P1 to gain from deviating [61]. This is applicable to all values between the thresholds for weak dominance; however, when we talk about 'far' values this is only applicable in a smaller interval (since P1 should not place more tokens on the table than S unless he aims for equal division).

PBNE without additional knowledge

We can also assess the Nash predictions when no additional information is given. In such scenarios players are not confronted with 'possible' DAs. Instead P1 can only base his decision on the actual DA whilst P2 solely has the table amount to base her decision upon. Thus, the best strategy for P2 is to decide randomly (since she has no way to assess the size of the table value and can be exploited otherwise); meanwhile, any random (non-zero) table value is considered an equilibrium strategy for P1[62].

[61] Note that P1 cannot gain from a systematic equal division strategy since the expected payoffs would be the same. This is not included for this analysis but is worthwhile being pointed out.
[62] Note that P1 would place exactly half of the division amount on the table if we added the assumption of risk aversion to the analysis.

Nash Conclusion

When participants receive AVs we find a number of Nash equilibria. There is an equilibrium in which the Splitter simply divides the DA in equal halves regardless his type; such equilibrium requires the Chooser to choose in accordance with weak dominance with a probability of at least 50% to ensure that the Splitter does not change his strategy[63]. Concretely, the Chooser chooses the table at least 50% of the time when $\frac{L}{2}$ is placed on the table whilst she chooses the suitcase at least 50% of the time when $\frac{S}{2}$ is placed on the table. Secondly, we find an equilibrium state in which the Splitter places half of the average of these threshold values on the table ($\frac{S+L}{4}$). For this to be an equilibrium state our Chooser needs to pick the table exactly 50% of the time. If the Chooser picks the table more frequently then the Splitter would rather make an equal division if the distribution amount is S (by placing $\frac{S}{2}$ on the table); whilst a Chooser-preference towards the suitcase would persuade the Splitter to make an equal division (by placing $\frac{L}{2}$ on the table) when the distribution amount is L.

Another equilibrium state is reached when the Splitter mixes between placing half of the DA on the table (i.e. equal division) and placing half of the average AV on the table. In this equilibrium the Chooser picks the table with probability equal or larger than 50% if half of the large value is placed on the table whilst she picks the suitcase with probability equal or larger than 50% if half of the small value is placed on the table (to prevent the Splitter from deviating). Whenever half of the average AV is placed on the table she picks the suitcase at exactly 50% of the time.

[63] Note that the 50% requirement is set such that the Splitter has no incentive to deviate from the equilibrium state as deviations would decrease his EP. Given weak dominance it makes sense to assume that the Chooser makes choices with 100% certainty (since one of the options cannot be worse than its alternative), however, such behaviour is not required to remain in the equilibrium state. If she were to pick in accordance with weak dominance with a probability of 70% then the Splitter would still not desire to deviate from the equilibrium state; and as long as the Splitter doesn't want to deviate the Chooser knows that she earns the same payoff regardless whether she picks the suitcase versus the table.

Finally, an equilibrium state exists in which the Splitter mixes between two (or more) strategies that are symmetrically equidistant from half of the average AV. The requirement is of course that he does not surpass the threshold values of dominance; and in case of 'far' values he should not place amounts larger than S on the table. The probability in which the Splitter uses his mixed strategy depends on the concrete DA and the mixed strategy he employs; for the Chooser the task is quite simple since her EP remains the same regardless her choice: she is indifferent. Due to her equilibrium requirements (i.e. she has to behave such that her opponent cannot gain from deviating from the equilibrium state) she picks the table and suitcase equally often regardless the concrete mixed strategy used by her opponent.

It is worthwhile to assess how the Nash predictions change if the assumption of risk neutrality is replaced by an assumption of risk aversion. This would result in a preference towards equal division by the Splitter (since he risks losing out by employing alternative tactics). Meanwhile, a risk averse Chooser would prefer the table amount if more than half of the average AV is displayed on the table (i.e. the expected value of the table is higher) whilst she prefers the suitcase if less than half of the average AV is displayed on the table.

If no AVs are provided then the Splitter should place a minimum of one token on the table (i.e. if the table contains zero tokens then Choosers would pick the suitcase since the suitcase cannot provide a worse pay-off). There are no other threshold values that Splitters needs to respect and thus he can randomly decide how many tokens to place on the table. Choosers do not have enough knowledge to assess whether the table versus suitcase provides a better pay-off and thus she should pick randomly. Under the assumption of risk averse behaviour the Nash equilibrium without AVs is for Splitters to divide the DA in equal parts; whilst the risk averse Chooser without AVs should still pick randomly.

Level k predictions

In this section we discuss the level k predictions for the suitcase game. We use a simplified notation to denote the level of reasoning for the Splitter as S_x whilst we denote the level of reasoning for the Chooser as C_x; the subscript 'x' refers to their level of reasoning. For example, S_0 refers to the Splitter reasoning at level zero. Our main assumptions are that each player considers themselves to reason exactly one level higher than their opponent and that they make a best response on the assumed behaviour of the opponent. Thus, S_x makes his decisions with the expectation that his opponent is C_{x-1} whilst C_x makes her decisions expecting that her opponent is S_{x-1}. We discuss level k predictions both under the assumption of risk neutrality and under the assumption of risk averseness.

First, we discuss the predictions for the simplest scenario namely risk neutral agents in a context without AV-knowledge. S_0 and C_0 are unsophisticated and make random decisions without considering the actions of the other player. At higher levels of reasoning decisions are based upon a best response strategy in relation to the expected actions of the opponent (who is assumed to be reasoning one level lower than themselves). Thus, S_0 randomly picks an amount from the interval $\left[0, \mathrm{DA}\right]$ whilst C_0 randomly decides whether to pick the table versus suitcase. Next, we reach level one. S_1 expects his opponent, C_0, to behave randomly and thus he again randomly picks an amount from the interval $\left[0, \mathrm{DA}\right]$ to place on the table. C_1 has no way to assess whether the table amount is smaller or larger than the suitcase amount and thus she still picks randomly. However, it should be noted that C_1 would always pick the suitcase if no tokens are transferred (since this provides a context in which the suitcase cannot be worse than the table). At level two the Splitter realises that he should never place zero tokens on the table and thus he randomly selects a transfer amount from the interval $\left]0, \mathrm{DA}\right]$. A stable state is reached at this point (see Table 51).

Table 51: Risk neutral level k predictions without AVs

	Splitter	Chooser
Level 0	Random choice	Random choice
Level 1	Random choice	Random choice

The scenario changes slightly when we assume risk aversion. We expect that a risk averse S_0 has an inherent desire to decrease the payoff difference due to his risk averse nature. Thus, S_0 is expected to place half of the DA on the table. The risk averse C_0 does not have any means to assess whether the table amount is small versus large and thus her risk aversion doesn't affect her behaviour: she randomly decides between the table and the suitcase. Next, we reach level one. S_1 expects his opponent, C_0, to behave randomly and thus he remains true to his risk averse desires by dividing the DA equally. Similarly, C_1 realises that her opponent simply divides the DA into equal segments and thus she cannot do better than randomly selecting the table or the suitcase. A stable state is reached (see Table 52).

Table 52: Risk averse level k predictions without AVs

	Splitter	Chooser
Level 0	Equal division	Random choice
Level 1	Equal division	Random choice

We now move on to the more complicated scenario in which AVs are provided. We again start by discussing level k predictions under risk neutrality after which we explore risk averse predictions. The risk neutral S_0 randomly decides how many tokens to place on the table (he is only limited by the DA as a maximum). Meanwhile C_0 randomly picks between the table and the suitcase. Next, we reach level one reasoning. S_1 randomly decides how many tokens to place on the table. Meanwhile, C_1 uses half of the average AV as a threshold value for her decision. If the table amount is larger than this threshold she picks the table whilst she picks the suitcase if the table amount is fewer than the threshold value. This is a best response since she expects the Splitter to behave randomly. Now we reach level two reasoning. S_2 tries to exploit his opponent's decision threshold: whenever the suitcase contains the smaller amount 'S' he places one token less than the threshold value on the table; whenever the suitcase contains the larger amount 'L' he places one token more on the table compared with the threshold value[64]. C_2 behaves the same as C_1: she picks the table whenever the table amount is larger than the threshold value whilst she picks the suitcase whenever the table amount is fewer than

[64] Note that he plays one token more on the table compared with the threshold since his opponent would choose the table amount (and thus he rather keeps the suitcase as large as possible); similarly when he plays one token less on the table compared with the threshold value this is because his opponent would choose the suitcase (and thus he wants to maximize the table value without passing the threshold). It is also worth pointing out to the reader that the Splitter will not divide into equal parts from level two onwards. Furthermore, this behaviour can only be due to randomness at level 0 and level 1 for risk neutrality.

the threshold value. Next, we reach level three. S_3 behaves the same as S_2 since their opponents behaved the same. Meanwhile, C_3 realises that her S_2-opponent has been exploiting her threshold heuristic and reverses her tactics. Thus, she selects the table whenever the table contains $\frac{\text{mean(AV)}}{2}-1$ tokens, whilst she picks the suitcase whenever the table contains $\frac{\text{mean(AV)}}{2}+1$ tokens. Next, we reach level four reasoning. S_4 is aware that his C_3-opponent uses a new decision rule and thus he reverses his own approach. Whenever the suitcase contains 'S' he places $\frac{\text{mean(AV)}}{2}+1$ on the table whilst he places $\frac{\text{mean(AV)}}{2}-1$ on the table if the suitcase contained 'L'[65]. At this point it should be clear that predictions continue cycling the same behaviour in a game of exploitation-attempts. A summary of these predictions is found in Table 53.

Table 53: Risk neutral level k predictions with AVs

	Splitter	Chooser
Level 0	Random choice	Random choice
Level 1	Random choice	If Table > $\frac{\text{mean(AV)}}{2}$: pick table If Table < $\frac{\text{mean(AV)}}{2}$: pick suitcase If Table = $\frac{\text{mean(AV)}}{2}$: pick randomly
Level 2	If S: place $\frac{\text{mean(AV)}}{2}-1$ on table If L: place $\frac{\text{mean(AV)}}{2}+1$ on table	If Table > $\frac{\text{mean(AV)}}{2}$: pick table If Table < $\frac{\text{mean(AV)}}{2}$: pick suitcase If Table = $\frac{\text{mean(AV)}}{2}$: pick randomly
Level 3	If S: place $\frac{\text{mean(AV)}}{2}-1$ on table If L: place $\frac{\text{mean(AV)}}{2}+1$ on table	If Table = $\frac{\text{mean(AV)}}{2}-1$: pick table If Table = $\frac{\text{mean(AV)}}{2}+1$: pick suitcase
Level 4	If S: place $\frac{\text{mean(AV)}}{2}+1$ on table If L: place $\frac{\text{mean(AV)}}{2}-1$ on table	If Table = $\frac{\text{mean(AV)}}{2}-1$: pick table If Table = $\frac{\text{mean(AV)}}{2}+1$: pick suitcase

[65] Note that the Splitter has to reverse his behaviour to outsmart the opponent. He cannot place other values on the table since it is unclear how the Chooser would respond to them (he may not gain from such strategies).

Finally, we discuss level k predictions for risk averse scenarios in which AV-knowledge is present. We expect that a risk averse S_0 has an inherent desire to decrease the payoff difference due to his risk averse nature. Thus, S_0 is expected to place half of the DA on the table. Meanwhile C_0 randomly decides between the table and the suitcase. Next, we reach level one. S_1 expects his opponent, C_0, to behave randomly and thus he remains true to his risk averse desires by dividing the DA equally. Similarly, C_1 realises that her opponent simply divides the DA into equal segments and thus she might as well pick randomly. A stable state is reached – with the same predictions as we had for risk averse scenarios without AV-knowledge (see Table 54).

Table 54: Risk averse level k predictions with AVs

	Splitter	Chooser
Level 0	Equal division	Random choice
Level 1	Equal division	Random choice

Maximin principle

Predictions from maximin principle are the same regardless provision of AVs. Concretely, maximin would predict that Splitters divide the DA into two equal segments since this ensures the largest possible minimum payoff. For Choosers the maximin predictions with AVs are that she picks the table whenever more than $\frac{S}{2}$ is placed on the table since this means that the suitcase might contain less than $\frac{S}{2}$ (in the worst case scenario, in which S was divided). Furthermore, she picks the suitcase if less than $\frac{S}{2}$ is placed on the table since the suitcase would surely contain a larger amount. Finally, if $\frac{S}{2}$ is placed on the table she can choose randomly since the table and suitcase have the same minimum value. When AVs are not provided maximin predictions for Choosers are simply 'random' behaviour (since she cannot assess which option provides the best payoff).

Experiment Four

Participants

Participants for Experiment Four were 36 students and employees from Warwick University. They were recruited through SONA, an online system for participant recruitment. Data on demographics is missing (due to a yearly SONA-maintenance which removed such data from the database). We ran three experimental sessions each consisted of exactly twelve participants (N=36). To avoid cancelling sessions due to participants not showing up we recruited four additional participants per session; if more than twelve participants showed up before the starting time we randomly selected participants to be send home with a £2 show-up fee. The possibility of being send home (due to an exact number of participants being required for the study) was advertised on SONA when participants signed up. Excluding participants happened through a procedure of shuffling a deck of cards (containing the cubicle numbers of all occupied computers) and randomly drawing one or more cards.

Participants were paid a show-up fee (£2) and an additional performance fee (£0-£10) based on a random lottery incentive system. The expected pay-off for the average participant is £5.80; and the average participant earned £5.76. Participants are told during an introductory PowerPoint explanation that they earn a performance fee based on the amount of tokens won in a randomly selected trial. We did not inform participant of the conversion rate (tokens to pounds) to avoid potential biases due to monetary expectations. Each token that is won in the randomly selected trial translated into an additional £0.15 in performance fee [66]. We did not provide participants with details regarding the random selection procedure for the 'performance fee' trial; concretely, a python script randomly selects a trial per participant to base their performance fee on. Different participants may be remunerated upon performance in different trials.

[66] This implies that theoretically the maximum performance fee is £15 (100 tokens); however, this is not too likely to occur given that it requires that (a) the randomly selected trial involves the highest distribution amount and that (b) P1 decides to transfer either zero tokens or the full amount. Hence, we advertised the experiment with a maximum performance fee of £10.

Materials

The experiment was performed in the Behavioural Science Lab; the coding was done by the author using a combination of python, HTML/CSS and willow. Participants faced a total of sixteen trials; and they swapped between being in the role of Splitter (P1) and being in the role of Chooser (P2) on each consecutive trial (to maximize fairness and exposure to both roles). They were randomly re-matched on every trial with an anonymous opponent and were aware of this. Random re-matching was programmed to be fully random; in theory participants can be matched twice in a row with the same opponent but they do not know who they play against. Half of the trials in each role involved additional knowledge in the shape of two AVs (i.e. Announced Values). This means that Splitters and Choosers are provided with two numerical values and the knowledge that one of these two values has been placed in the suitcase (with equal probabilities for both amounts; and with both players knowing the same two numerical values). For practical reasons we refer to the smaller AV as 'S' whilst we refer to the larger AV as 'L'. Concretely, we used four amounts (i.e. 28, 32, 36 and 40) as Small AVs and computed a corresponding (close and far distanced) Large AV for each of these amounts. We speak of close distanced values when the larger amount consists of the small amount multiplied by one and a half (i.e. $L = S \times \frac{3}{2}$); we speak of far distanced values when the larger amount consists of the small amount multiplied by two and a half ($L = S \times \frac{5}{2}$) (see Table 55).

Table 55: Value pairs used in the experiment

Small	Large	
	Close	Far
28	42	70
32	48	80
36	54	90
40	60	100

By (separately) combining each small value with both its close and far distanced large value we end up with eight AV-pairs. Four of these pairs are randomly selected to be played in the initial role whilst the remaining pairs are played in the ending role[67]. Of the selected four pairs we then randomly picked two

[67] We use the terms ‘initial’ versus ‘ending’ role since participants start in different roles (some are first Splitters whilst others are first Choosers) but they are matched together such that they face the same trials in their ‘initial’ role (just from the opposite perspective).

pairs to involve AV-knowledge; the two remaining pairs could have balanced for ‘distance’ (close versus far AVs) but sadly this was not implemented in the experimental programming[68]. Table 56 provides the reader with a hypothetical example of trial creation.

Table 56: Hypothetical example of trial creation

Role	Paired values	AV-knowledge
Initial Role	40-60	Yes
Initial Role	28-70	Yes
Initial Role	36-90	No
Initial Role	32-80	No
Ending Role	32-48	Yes
Ending Role	36-54	Yes
Ending Role	40-100	No
Ending Role	28-42	No

Each of the eight scenarios that is created in this way occurs twice – once the DA is the large value 'L'; and once the DA is the small value 'S'. This results into a total of eight trials in either role; the trial order is randomized separately for trials in the initial role and in the ending role after which the two trial lists are zipped together such that participants change role on every trial. We remind the reader that everyone who plays in the same group faces the same scenarios in the same order but the independent groups (even in the same session) follow a different trial order.

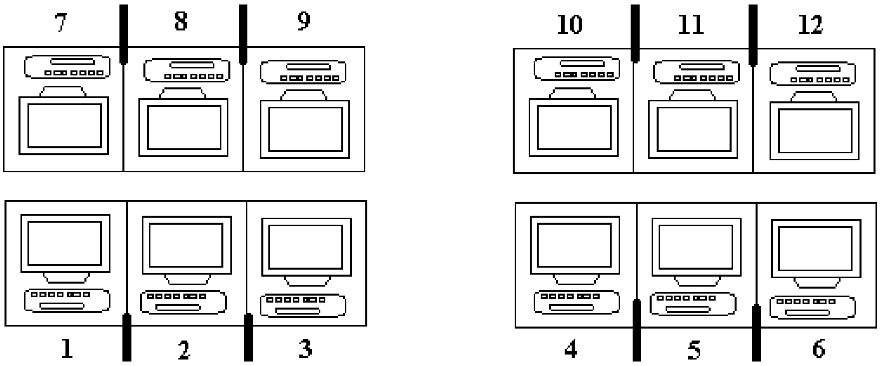
Finally, it is worthwhile to point out that we subdivided each experimental session into two mini-sessions. Concretely, sessions consist of twelve participants; six of them are placed in 'Mini-Session A' whilst the other six are placed in 'Mini-Session B'. Participants can only be matched with others from the same mini-session. We did not inform participants that they are in one of two mini-sessions as this would affect their perspective on potential opponents to be (re-)matched with. The logic behind these independent mini-sessions is to maintain the same prior experience for participants who are matched together whilst decreasing the risk of biases due to sequence effects (i.e. we now use twice as many randomly generated trial orders). Every trial participants are randomly re-matched and they do not know who they are matched with. We did not drop variables, conditions or trials from our analysis.

[68] When the experiment was programmed the author randomized the order of the pairings and overlooked the distance inside each value pair.

Procedure

The experiment consisted of three experimental sessions each consisting of exactly 12 participants (N=24). A 60-minute timeframe was available for each session and sessions typically lasted 45 minutes. Using an alphabetical listing of signed-up participants we allocated everyone to numbered cubicles. The experiment is set-up such that adjacently seated participants have the same starting role; though they are unaware of this feature (see Figure 76).

Figure 76: Experimental setup for the Suitcase Game



This figure provides a schematic overview of our experimental layout. Participants sit in two rows of desks each with a computer. Shutters (partitions) are used such that they can only see their own computer. Participants in the same row (e.g. 1-6) start the experiment in the same role.

If more than twelve people showed up we would randomly exclude participants by blindly selecting a cubicle number from a pack of numbered cards after shuffling the cards in front of the participants. Excluded participants received a £2 show-up fee and filled in a payment receipt after which the doors were closed and the experimental setup was explained by means of a PowerPoint presentation (see Appendix 3.1 for details on instructions). The main points from the PowerPoint instructions are shortly summarized below:

> This game revolves around a suitcase with an unknown amount of valuable tokens and a table with a known amount of tokens. It is played by two players who have different tasks during the game. Initially both players share the same knowledge regarding the unknown suitcase amount. Either both have no information regarding the suitcase value; or they are both given the same two numerical amounts with the knowledge that one of these two amounts is certain to be found in the suitcase (and that both amounts are equally likely). You are randomly re-matched with an anonymous player on each trial; one of you is assigned the role of 'Splitter' (Player One) whilst the other is assigned the role of 'Chooser' (Player Two).

> The game is setup such that the Splitter privately looks at the token contents of the suitcase and decides upon an amount of tokens to take from the suitcase; this amount is placed visibly on the table. Concretely, the content of the suitcase are displayed on his screen as a numerical amount and he types an integer value into a textbox; his choice becomes final after he presses a 'continue' button. The Chooser has no idea what contents are left in the suitcase but she knows how many tokens are placed on the table. Her task is to decide whether she rather has the known amount of tokens from the table or the unknown amount of tokens from the suitcase; the unchosen option is given to the Splitter. Concretely, she sees a numerical value displayed as the table amount (and knows that this value is deducted of the initial suitcase content) but she does not know how many tokens are left in the suitcase. Using a 'table' versus 'suitcase' button she decides which option she wants for herself.
>
> Feedback is provided after every trial specifying which option you received (i.e. suitcase versus table) and what its token content is; furthermore, feedback also informs you of the option received by the other player and its token content. After each trial your role swaps (i.e. Splitters become Choosers and Choosers become Splitters) and you are randomly re-matched with another player for the next trial. A total of sixteen trials is played for the experiment. Regarding your final payment you receive a participation fee of £2 and additionally you earn a performance fee based on the amount of tokens you win in a randomly selected trial.

Participants were given the opportunity to raise their hand if further clarification was required and were informed that they could do so at any time during the experiment if they had further questions. Before starting the experiment participants were asked to put their electronic devices and notes away. Furthermore, between each experimental cubicle we pulled out ‘shutters’ (i.e. partitions) to avoid the temptation of glancing on a neighbour’s computer screen. Before the experiment started we provided participants with four practice trials to get familiar with the task and experimental setup; we stressed that the practice trials are unrelated to experimental trials and that they simply serve for task familiarity. At the end of the experiment pay-offs were calculated using a python script. Concretely, the script randomly generates a trial number for each participant and assesses how many tokens they won on that particular trial. Tokens are multiplied by a factor of 0.15 to generate the performance fee and a two pounds show-up fee is added in. The python script does this for every participant and makes a clean output file with a summary of cubicle numbers and payments. At the end of the first session of Experiment Four we asked participants to play a variation of the experimental game involving cheap talk whilst the experimenter computed their payoffs. This variation involved hypothetical scenarios (i.e. they could not earn monetary rewards and were informed of this) and was simply meant to assess whether this is worthwhile to explore in the future. Preliminary data of this variation is not discussed in the chapter but can be found in Appendix 3.2.

Finally, participants fill in receipts for payment and are asked to come forward when we call their cubicle number to receive payment in exchange for their receipt ticket. Data from the experiment is stored in a time-stamped folder containing a multitude of CSV-files (i.e. one for each trial played by each participant ─ in case the program were to malfunction not all data would be lost) and these are converted into a big CSV-datafile using a python script. The data is analysed using RStudio.

Experiment Five

We used the same procedure and materials for Experiment Five as were used for Experiment Four. The main differences with the previous experiment are that we only ran two twelve-person sessions for Experiment Five (N=24) and that none of the trials in Experiment Five involved AV-knowledge (i.e. AVs were not even mentioned). The average payoff in this experiment was £5.85. The central aim of this variation is to compare behaviour in 'no knowledge' trials from Experiment Four with behaviour in 'never knowledge' trials from Experiment Five. A summary of the task description is:

> This game revolves around a suitcase with an unknown amount of valuable tokens and a table with a known amount of tokens. It is played by two players who have different tasks during the game. You are randomly re-matched with an anonymous player on each trial; one of you is assigned the role of 'Splitter' (Player One) whilst the other is assigned the role of 'Chooser' (Player Two).
>
> The game is setup such that the Splitter privately looks at the token contents of the suitcase and decides upon an amount of tokens to take from the suitcase; this amount is placed visibly on the table. Concretely, the content of the suitcase are displayed on his screen as a numerical amount and he types an integer value into a textbox; his choice becomes final after he presses a 'continue' button. The Chooser has no idea what contents are left in the suitcase but she knows how many tokens are placed on the table. Her task is to decide whether she rather has the known amount of tokens from the table or the unknown amount of tokens from the suitcase; the unchosen option is given to the Splitter. Concretely, she sees a numerical value displayed as the table amount (and knows that this value is deducted of the

initial suitcase content) but she does not know how many tokens are left in the suitcase. Using a 'table' versus 'suitcase' button she decides which option she wants for herself.

Feedback is provided after every trial specifying which option you received (i.e. suitcase versus table) and what its token content is; furthermore, feedback also informs you of the option received by the other player and its token content. After each trial your role swaps (i.e. Splitters become Choosers and Choosers become Splitters) and you are randomly re-matched with another player for the next trial. A total of sixteen trials is played for the experiment. Regarding your final payment you receive a participation fee of £2 and additionally you earn a performance fee based on the amount of tokens you win in a randomly selected trial.

Hypotheses

Various interesting patterns have been found in the literature concerning experimental games. In this chapter we decided to explore whether some of these findings hold true in our own experimental game. Güth and Van Damme (1998) ran a three-person UG in which the third person is an inactive participant. The proposer suggests a payoff distribution assigning monetary values to himself, the responder and the inactive third player. It is common knowledge that the responder either receives information about (a) the full payoff distribution, (b) solely his own payoff, (c) or solely the payoff of the third player. Their findings indicated that proposers claim the largest part when irrelevant information is provided to the responder; they claim somewhat less when the responder is provided with knowledge on his payoff; and they claim even less when information on all payoffs is provided. Since the UG has some similarities with our own design (see Chapter 1) we hypothesize that Splitters may distribute more equally when AVs are provided compared to scenarios in which they are not provided. This seems intuitive since it is harder to get away with trickery attempts in contexts where the opponent is more knowledgeable. Our second hypothesis is based on a study by Hoffman, McCabe and Smith (1996). These authors compared divisions of small and large amounts in an UG-setting and concluded that the data is indistinguishable. Given that their study involved perfect information whilst ours involves asymmetric information (allowing psychological trickery attempts)[69] we wonder whether the same result could be found. Our second hypothesis is thus that the same divisions are made for small and large distribution amounts. Our third hypotheses relates to high versus low stakes. A paper by Post, Van den Assem, Baltussen and Thaler (2008) compared data from a TV gameshow with high stakes and classroom replication experiments with lower stakes. They found that choices involving small versus large stakes are remarkably similar and that choices are in large part affected by previous outcomes in the game. For our own experimental setup stakes are higher when far values are involved compared with close values (i.e. more can be gained or lost in scenarios with far values). A main difference between their design and ours is that participants played a game against nature in Post et al. (2008) whilst our participants play a competitive game against other strategic agents. Thus, the third hypothesis is that the distance variable (far versus close) does not affect experimental behaviour. Finally, Gigerenzer & Goldstein, (1996) have suggested that heuristics may sometimes work equally well (or better) compared with complex decision rules. Thus, we postulate the hypothesis that Chooser behaviour can be explained through simple heuristics. Concretely, we focus on three ideas. Firstly, we explore whether Chooser behaviour in a context without AV-knowledge can be explained through a decision threshold that is based upon the average DA from past trials (i.e. knowledge that can be gained from feedback). This idea is inspired on the fictitious play algorithm discussed in Seale and Phelan (2010) but works differently since our own participants are randomly re-matched on every trial (and thus they cannot exploit biases of specific opponents; but they can learn what values to expect). Secondly, we employ a heuristic of representativeness (Tversky & Kahneman, 1975) for trials with AV-knowledge: Choosers may assess whether the distribution amount is more likely to be 'S' (i.e. the small AV) versus 'L' (i.e. the large AV) by comparing the table amount with half of the average AV. If the table amount lies closer to $\frac{L}{2}$ (i.e. it is larger than the average AV) then the Chooser may expect that 'L' was divided and act accordingly; whilst if the table amount lies closer to $\frac{S}{2}$ (i.e. it is smaller than the average AV)

[69] For example, when the Splitter divides a small DA he can place the majority on the table since it would appear 'small'; whilst he may keep the majority in the suitcase when dividing a large DA since the table amount could appear 'large' already.

then P2 may expect that ‘S’ was divided and act accordingly[70]. And our final heuristic looks at previous outcomes. Post et al. (2008) suggested that decisions (both in a TV gameshow and in their own laboratory-replication) are strongly affected by previous outcomes. We thus explore whether there is relationship between Chooser behaviour in the current trial and the ‘best outcome’ (i.e. table or suitcase) on the previous trial (in the same or opposite role).

Our hypotheses are summarized in Table 57.

Table 57: Hypotheses for the suitcase game

Hypothesis 1:	Splitters divide more equally when AVs are provided
Hypothesis 2:	The same divisions are made when the DA is S versus L
Hypothesis 3:	Distance between AVs does not affect behaviour
Hypothesis 4:	Heuristics can explain Chooser behaviour
4A)	Behaviour without AVs can be explained through the mean distribution amount (MDA) from past trials
4B)	Behaviour with AVs can be explained through the average AV
4C)	Behaviour (with and without AVs) can be explained based upon previous outcomes

Results

Splitter Behaviour

Similar to previous chapters we describe predictions from theoretical frameworks in terms of strategy profiles[71]. We use subscripts ‘N’ and ‘A’ to refer to the risk attitude of certain predictions (see Table 58 and Table 59).

Table 58: Strategy profiles for Splitters with AVs

	Amount placed on the table		Frameworks
	Divide S	Divide L	
Profile 1	$\frac{S}{2}$	$\frac{L}{2}$	$Nash_N$, $Nash_A$, Maximin, $levelK_A$
Profile 2	Random	Random	$level1_N$
Profile 3	$\frac{S+L}{4}$	$\frac{S+L}{4}$	$Nash_N$
Profile 4	$\frac{S+L}{4}-1$	$\frac{S+L}{4}+1$	$level2_N$

[70] This heuristic is also in line with the predictions for risk neutral level one behaviour and the predictions for risk averse Nash behaviour.

[71] As was the case in the previous chapters we do not include mixed strategies for our discussion here since they are too difficult to compare with our experimental data and since human decision makers rarely attempt to use mixed strategies according to the literature.

Profile 5	$\frac{S+L}{4}+1$	$\frac{S+L}{4}-1$	$level4_N$

All behaviour that cannot be explained by the other profiles is considered under the 'random' profile[72]. We did not include the mixed strategy suggested by $Nash_N$ in which the Splitter uses strategies that are equidistant from half of the average AV given that this cannot be assessed from our data. Given the complexity of some of these strategy profiles it appears that profile 1 and 2 may the easiest for participants to adopt. These same two profiles are the only ones that can occur without AVs (see Table 59).

Table 59: Strategy profiles for Splitters without AVs

	Amount placed on table		Frameworks
	Divide S	Divide L	
Profile 1	S/2	L/2	$Nash_A$, Maximin, $levelK_A$
Profile 2	Random	Random	$levelK_N$, $Nash_N$

We now discuss observed Splitter-behaviour according to these strategy profiles using data from Experiment Four . Profiles 3, 4 and 5 are greyed-out (since are rarely observed) to facilitate visual comparison between the remaining profiles. Each participant has four observations with AVs and four observations without AVs (see Table 60).

Table 60: Splitter behaviour according to the suggested profiles

	With AVs						Without AVs	
Subject	Profile 1	Profile 2	Profile 3	Profile 4	Profile 5		Profile 1	Profile 2
0	0	3	1	0	0		0	4
1	2	2	0	0	0		1	3
2	0	2	2	0	0		0	4
3	4	0	0	0	0		0	4
4	0	2	2	0	0		0	4
5	4	0	0	0	0		4	0
6	2	2	0	0	0		0	4
7	0	4	0	0	0		1	3
8	0	4	0	0	0		0	4
9	1	3	0	0	0		0	4
10	4	0	0	0	0		4	0
11	0	4	0	0	0		0	4
12	3	1	0	0	0		0	4
13	2	2	0	0	0		1	3

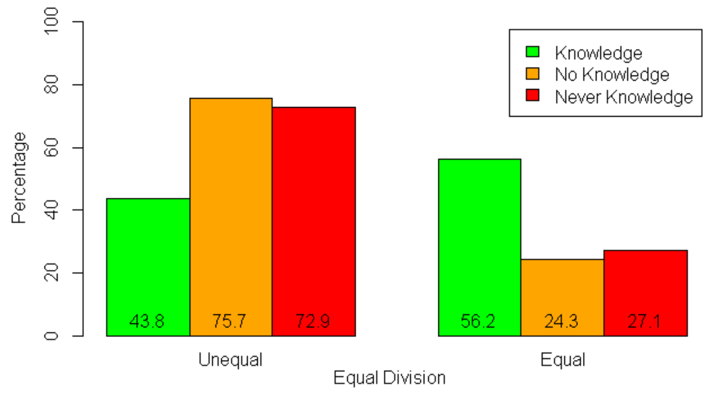
[72] In this game we consider behaviour that diverges from our most straightforward predictions to be 'random' – this coding cannot be applied to the previous chapters since all behaviour could be explained in such a context (i.e. the other games have a low number of available strategies for P1).

14	4	0	0	0	0		4	0
15	3	1	0	0	0		2	2
16	3	1	0	0	0		4	0
17	1	2	1	0	0		0	4
18	4	0	0	0	0		1	3
19	0	4	0	0	0		0	4
20	4	0	0	0	0		1	3
21	2	2	0	0	0		0	4
22	4	0	0	0	0		4	0
23	4	0	0	0	0		1	3
24	3	1	0	0	0		1	3
25	1	2	1	0	0		0	4
26	3	1	0	0	0		0	4
27	3	1	0	0	0		0	4
28	4	0	0	0	0		1	3
29	2	2	0	0	0		0	4
30	1	3	0	0	0		0	4
31	2	2	0	0	0		0	4
32	3	1	0	0	0		0	4
33	2	2	0	0	0		3	1
34	2	2	0	0	0		2	2
35	4	0	0	0	0		0	4

We conclude that both with and without AVs theories only explain behaviour when they predict equal division or random behaviour. Furthermore, skimming through the data with and without AVs suggests that random behaviour might be more frequent in scenarios without AVs. This can be explained from a simple comparison between Table 58 and Table 59; there are more theories suggesting random behaviour without AVs compared to with AVs and additionally there are less frameworks suggesting equal division with AVs compared to without AVs. However, this also relates to one of the hypotheses we wanted to explore so we take a closer look at these cases. Figure 77 displays the percentage of trials on which Splitters divide the DA into equal segments depending on AV-knowledge. Considering that this figure uses data from both Experiment Four (knowledge and no knowledge) and Experiment Five (never knowledge) we converted data to percentages since the 'never knowledge' condition has more data points[73].

Figure 77: The effect of AV-knowledge on equality

[73] We ran three sessions in which half of the trials provided AVs (knowledge trials) whilst the other trials did not provide AVs (no knowledge trials); the experiment in which none of the trials involved AVs only had two sessions but all of its trials are 'never knowledge' trials.



This figure displays the effect AV-knowledge has on the frequency of equal division by Splitters. Knowledge and No Knowledge trials represent data from Experiment whilst Never Knowledge trials are from Experiment Five.

In aggregate Splitters make equal splits more frequently in trials where AV-knowledge is provided compared to no knowledge and never knowledge trials. No knowledge and never knowledge trials do not appear to differ in relation to equal division behaviour suggesting that the presence of AVs on some trials does not affect behaviour in trials without AVs. A within participants comparison between knowledge and no knowledge trials is made in Appendix 3.3. Approximately two thirds of our Splitters divide more equally in knowledge scenarios compared to no knowledge scenarios; and one third does it equally often in either scenario. Only three Splitters (out of 36) made equal splits more frequently in scenarios without knowledge than they did in scenarios with knowledge. We conclude that Splitters divide more equally when AVs are given which provides basic support for hypothesis one.

Next, we explore whether the Splitter makes the same divisions when the DA is S versus L. It is possible that the Splitter attempts trickery, for example by placing a large proportion of the DA on the table when dividing S whilst placing a small proportion of the DA on the table when dividing L (such that the opponent is tempted to pick the worse option). Thus we make a comparison of the frequencies in which the table amount is smaller, equal or larger compared with the suitcase amount for each of the knowledge conditions. We point out to the reader that the same amounts are considered small (S) versus large (L) across condition to allow comparison even though participants can make different assessments in the conditions were AVs are not provided. Data from ‘far’ and ‘close’ trials is merged together into AV-knowledge trials to be consistent across conditions. The most frequent strategy of each row is indicated by a bold font (see Table 61 and Table 62).

Table 61: Splitter behaviour dividing small values

		Table < Suitcase	Table = Suitcase	Table > Suitcase
Exp 4	Knowledge	3	**39**	30
	No Knowledge	9	13	**50**
Exp 5	Never Knowledge	34	25	**37**

Table 62: Splitter behaviour dividing large values

		Table < Suitcase	Table = Suitcase	Table > Suitcase
Exp 4	Knowledge	27	**42**	3
	No Knowledge	**32**	22	18
Exp 5	Never Knowledge	**50**	27	19

Looking at no knowledge and never knowledge trials we see evidence of trickery attempts. When the large amount is divided most Splitters keep the largest chunk hidden in the suitcase; and when the small amount is divided most Splitters display the largest chunk on the table. Given that Choosers have no knowledge to assess the relative size of the table amount this suggests that Splitters try to trick their opponent by placing a seemingly large value on the table when the suitcase contains more tokens whilst placing a seemingly small value on the table when the suitcase contains even less tokens. This line of reasoning can potentially be explored further through verbal protocols. Another comparison of interest is between behaviour in ‘no knowledge’ and ‘never knowledge’ scenarios. For small amounts we observe more random looking behaviour in the never knowledge condition. It is unclear why such a difference is found. It may be that the ‘no knowledge’ condition allows faster learning of the expected DAs since it is intermixed with ‘knowledge’ trials which is not the case for the ‘never knowledge’ condition.

When AVs are provided the most frequent tactic is an equal division both for S and L. This suggests that Splitters are less keen on trickery attempts when their opponent becomes more knowledgeable. The reader may notice that the second most frequent strategy for the knowledge condition differs between the two tables; this difference is in line with the same trickery-idea as before, however, such difference *should* be found due to the strong dominance that is involved with the provision of

AVs.[74]. We thus explore Splitter-behaviour in context of AV-knowledge through a coding that compares the table amount with the two AVs (see Table 63).

Table 63: Splitter behaviour in relationship to the AVs (i.e. S and L)

		$<\frac{S}{2}$	$=\frac{S}{2}$	$\left]\frac{S}{2},\frac{S+L}{4}\right[$	$=\frac{S+L}{4}$	$\left]\frac{S+L}{4},\frac{L}{2}\right[$	$=\frac{L}{2}$	$>\frac{L}{2}$
Small (S)	Close	2	22	3	2	3	5	2
	Far	1	17	6	0	9	0	0
Large (L)	Close	1	3	3	5	4	20	3
	Far	1	2	5	0	3	22	0

We observe a few errors against strong and weak dominance (i.e. cells with orange background). Furthermore, as we pointed out in the previous tables the most frequent strategy for either type is to divide equally (i.e. cells with green background). One observation of interest is that half of the average AV is occasionally placed on the Table – which corresponds to a prediction made by (risk neutral) Nash – but this solely occurs for close AVs. However, when we explore the frequency in which half of the average AV is placed on the Table for trials without AV-knowledge we observe the same behaviour on 8 occasions, suggesting it to be an artefact of the experimental procedure.

Furthermore, it is possible to assess a relationship between the DA being S versus L and experimental behaviour both for close and far distanced AVs though this requires us to combine the columns $\left]\frac{S+L}{4},\frac{L}{2}\right[$ and $\frac{L}{2}$ for the 'far' distanced observations (given that the far distanced Splitter cannot place half of the large amount on the Table when he divides S (since S$<\frac{L}{2}$ for far scenarios)). At face

[74] Splitters should never place fewer tokens on the table than that are kept in the suitcase when they divide ‘S’ since this implies that less than $\frac{S}{2}$ is placed on the table – i.e. providing a strongly dominant strategy for the Chooser. The same is true when Splitters divides ‘L’: they should never place more tokens on the table than that are left in the suitcase since it implies that more than $\frac{L}{2}$ is placed on the table already. As a numerical example consider S=40 and L=60. If P1 divides L and places more tokens on the table than he leaves in the suitcase the scenario is at minimum Table=31, Suitcase=29. Whenever 31 tokens (or more) are placed on the table the Chooser would rationally pick the table given these AVs due to strong dominance (i.e. the suitcase would contain only 29 or 9 tokens whilst the table contains 31 tokens). Similarly if the Splitter divides S and places fewer tokens on the table than that the suitcase then the scenario is at minimum Table=19, Suitcase=21. Whenever 19 (or less) tokens are placed on the table the Chooser would rationally pick the suitcase given these AVs due to strong dominance (i.e. the suitcase will contain 21 or 41 tokens whilst the table contains only 19 tokens).

value there does not appear to be a relationship between distance and experimental behaviour though our exploration is heavily limited in its number of datapoints.

Chooser Behaviour

First, we summarize the strategies suggested by the frameworks we discussed earlier (see Table 64).

Table 64: Chooser strategies with AVs

	Amount placed on the table	Frameworks
Profile 1	$\frac{S}{2}$: pick suitcase 50%+ $\frac{S+L}{4}$: pick table 50% $\frac{L}{2}$: pick table 50%+ Between S/2 and L/2: pick table 50%	Nash_N
Profile 2	$<\frac{S+L}{4}$: pick suitcase $\frac{S+L}{4}$: pick randomly $>\frac{S+L}{4}$: pick table	Nash_A, level1_N
Profile 3	$>\frac{S}{2}$: pick table $\frac{S}{2}$: indifference $<\frac{S}{2}$: pick suitcase	Maximin
Profile 4	$\frac{S+L}{4}-1$: pick table $\frac{S+L}{4}+1$: pick suitcase	level3_N
Profile 5	$\frac{S+L}{4}-1$: pick suitcase $\frac{S+L}{4}+1$: pick table	level5_N

Without AVs Chooser strategies are to behave randomly (Nash_N, Nash_A, levelK_N, levelK_A)[75]. It thus seems hard for these frameworks to explain a variety of Chooser behaviour. Especially, since we saw that Splitter behaviour consists mainly of a mixture of equal divisions and random-looking decisions. Given the multitude of possible scenarios that Choosers can face when Splitters make random choices[76] we are limited to what we can realistically assess. We summarize Chooser behaviour

[75] We also predict random behaviour for the risk averse level k reasoner with AVs; however, 'random' behaviour is quite hard to assess so this prediction is not included in our table.

[76] We remind the reader that different trials involve different DAs going up to a maximum of 100 tokens; and that any integer amount of tokens (up to the full value of the DA) can be placed on the table. Thus, we cannot look at all possible scenarios that occur in an ordered fashion.

by dividing scenarios based upon the table amount ‘x’ lying between specific threshold values (see Table 65).

Table 65: Chooser behaviour with AVs

		$<\frac{S}{2}$	$=\frac{S}{2}$	$\left]\frac{S}{2},\frac{S+L}{4}\right[$	$=\frac{S+L}{4}$	$\left]\frac{S+L}{4},\frac{L}{2}\right[$	$=\frac{L}{2}$	$>\frac{L}{2}$
Table	Close	0	5	1	3	5	18	5
	Far	0	0	2	0	6	11	0
Suitcase	Close	3	20	5	4	2	7	0
	Far	2	19	9	0	6	11	0

Comparing aggregate Chooser behaviour with the strategy profiles suggested by theoretical frameworks we observe a decent fit for profile 1 and especially for profile 2. In this context we also point out to the reader that ‘far’ scenarios in which the suitcase is chosen despite the Table containing $\frac{L}{2}$ should not be seen as contradictive for predictions since Choosers can deduce that the Suitcase initially contained the large amount whenever half of the large AV is placed on the Table. Specifically, half of the large AV in ‘far’ scenarios is always larger than the small AV and thus it can be deduced that both Table and Suitcase contain the exact same value in this context[77]. It should be clear that profile 3 is ineffective to explain behaviour and that profile 4 and 5 are too specific (i.e. Splitters never made the exact choices related to profile 4 and 5 making it hard to assess how Choosers would behave in those contexts).

Next, we briefly discuss errors against dominance (cells with an orange background colour). We remind the reader that ‘far’ scenarios in which the suitcase is chosen despite the table containing half of ‘L’ does not constitute weak dominance since this amount is by definition larger than the full value of ‘S’. We do not observe any errors against strong dominance by Choosers; however, we see a few errors against weak dominance. Furthermore, as could be expected Choosers are more likely to pick the table when the table-amount becomes larger whilst they are more likely to pick the suitcase when the table amount becomes smaller; however, Choosers also display a general preference towards the Suitcase. Furthermore, it is

[77] As numerical example: S=40 and L=100. When half of L (i.e. 50 tokens) is placed on the table then it is clear that only ‘L’ could have been divided since 50>40.

worth mentioning that this suitcase-preference only surfaces when AVs are included. When AVs are not known there is a preference towards the Table (see Table 66).

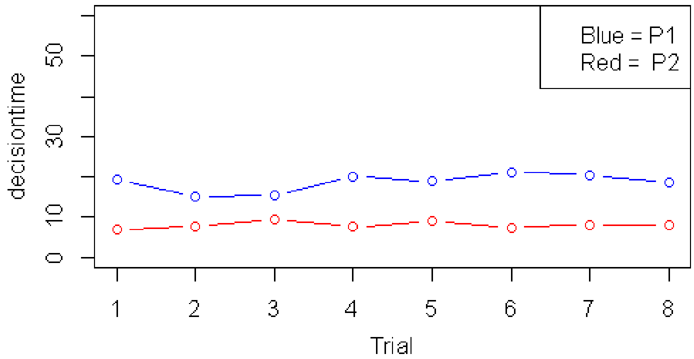
Table 66: Chooser behaviour and knowledge in Experiment Four

	Knowledge	No knowledge
Table chosen	56	82
Suitcase chosen	88	62

This observation is in line with findings from Van Dijk and Zeelenberg (2007) that additional knowledge increases curiosity about a ‘sealed package’. Furthermore, their study suggests that curiosity flourishes even more strongly if feedback (regarding the suitcase amount) becomes conditional on the Chooser’s decision. This may be interesting to explore for our own design in a future experiment given that the Sealed Package Paragdigm introduced by Van Dijk and Zeelenberg (2007) did not explore the context of strategic opponents[78].

Finally, we explored whether heuristics do a good job explaining Chooser behaviour since it is quite challenging from the perspective of typical theories and models. We first explored whether decision time decreases over time as this may indicate learning effects or usage of a heuristic (see Figure 78).

Figure 78: Evolution of decision time over trials



This figure displays the evolution in decision time across the eight trials played as Splitter (blue) and as Chooser (red). The x-axis represents the chronological order of facing trials in a particular role while the y-axis represents decision time in seconds.

[78] Concretely, the participants of their experiment chose between a fixed monetary amount and a ‘sealed package’ as remuneration for their participation to a study. In other words, their choice was not against an agent with competitive interests unlike our own experiment.

There is no clear evolution in decision time over trials[79]. Despite the pessimistic indication provided by decision times we still explored a number of heuristics that may explain decision-making for Choosers. Our first heuristic aims to explain behaviour for trials without AVs. Concretely, we hypothesize that Choosers base their decisions on a specific threshold amount: when the table contains fewer tokens than the threshold value she picks the suitcase whilst she picks the table in scenarios where the table amount contains more tokens than the threshold value (and she is indifferent between the table and suitcase whenever the table amount equals the threshold value). We based our threshold value on an idea suggested by Seale and Phelan (2010) in their study on bluffing and betting behaviour. These authors discussed the 'fictitious play' (FP) algorithm introduced by Brown (1951)[80]. This algorithm involves an iterative method in which players keep track of past choices to select the strategy yielding the largest expected value. We found inspiration for a heuristical threshold from this idea but made a few modifications since our own participants (know that they) are randomly re-matched on every trial – implying that they cannot exploit the biases of a particular opponent. Concretely, we used the knowledge of DAs from past trials (in either role) to compute the mean distribution amount (MDA). Participants have this knowledge available through feedback at the end of each trial (i.e. they simply need to sum the suitcase and table amounts to know the DA of the last trial). Such MDA-computation provides the Chooser with an expectation regarding the value that the Splitter may be dividing. It may be too challenging to actually compute the MDA-value, however, an intuition on the MDA may well be what guides decisions. With our first heuristic we thus assess whether half the MDA-value provides a decision criterion that can explain behaviour when AVs are not present. A numerical example would be that the DAs of past trials are 50, 70, 80 and 40 tokens. This means that the MDA equals 60 tokens. According to the heuristic the Chooser would then pick the table if more than 30 tokens (i.e. 60/2) are placed on the table; whilst she would pick the suitcase if less than 30 tokens are placed on the table. To express such heuristical relationship we created a graphical representation of Chooser data in which the X-axis represents the difference between the MDA on a specific trial and the table amount on that trial; meanwhile the Y-axis

[79] We also explored whether individual Choosers display a decision time evolution across their trials. These graphs displayed the same lack of 'evolution' and are hence not included in the chapter.
[80] I could not locate the original paper by Brown, so my understanding of the FP algorithm is based on the paper by Seale and Phelan.

represents whether the table versus suitcase was chosen by the Chooser. Furthermore, numerical values specify how many observations are in each section of the graph. The expectation is that the Suitcase is preferred when the MDA is larger than the Table amount (i.e. MDA-Table > 0) whilst the Table is preferred when the MDA is smaller than the Table amount (i.e. MDA-Table < 0). This tendency is present in all three conditions but is stronger when AVs are not provided or never provided (see Figure 79**,** Figure 80 and Figure 81).

Figure 79: Chooser Heuristics: MDA with AVs

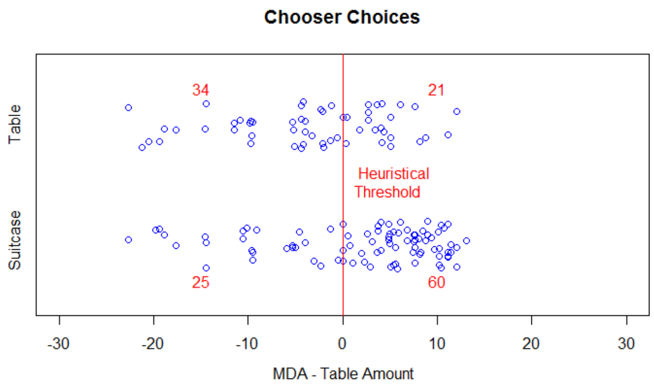


Figure 80: Chooser Heuristics: MDA without AVs

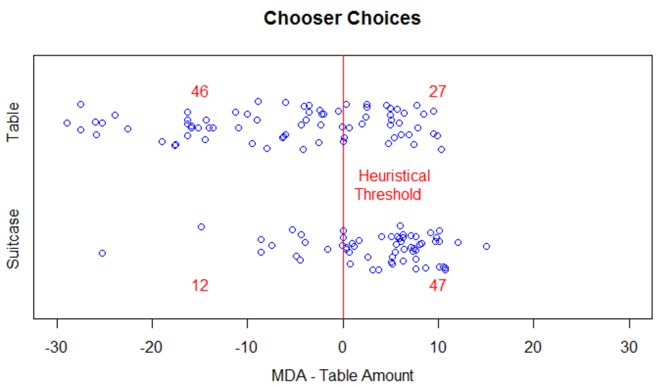
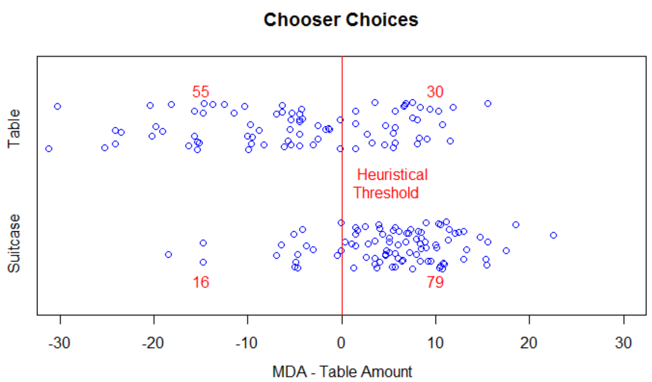


Figure 81: Chooser Heuristics: MDA with never AVs



A second heuristic we can explore is concerned with the knowledge provided in AV-trials. Concretely, we expect Choosers to use half of the average AV as a threshold value[81]. Our expectation is that the Suitcase is preferred when the Table amount is less than the Mean AV (i.e. Mean AV – Table > 0) whilst the table is preferred when the Table amount is more than the Mean AV (i.e. Mean AV – Table < 0). However, this heuristic should not be effective when AV knowledge is unavailable (i.e. No/Never AVs) given that Choosers don't have access to the threshold on such trials.

Figure 82: Chooser Heuristics: Mean AV with AVs

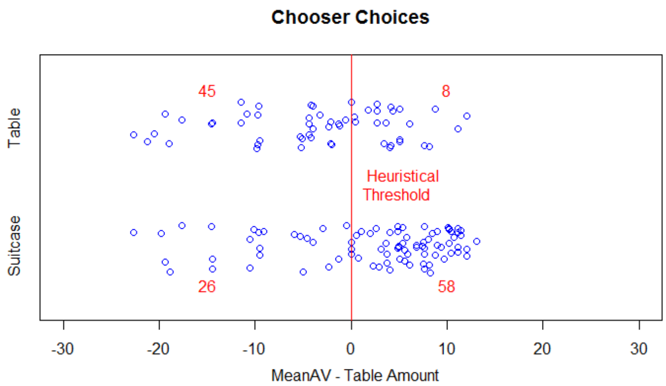


Figure 83: Chooser Heuristics: Mean AV without AVs

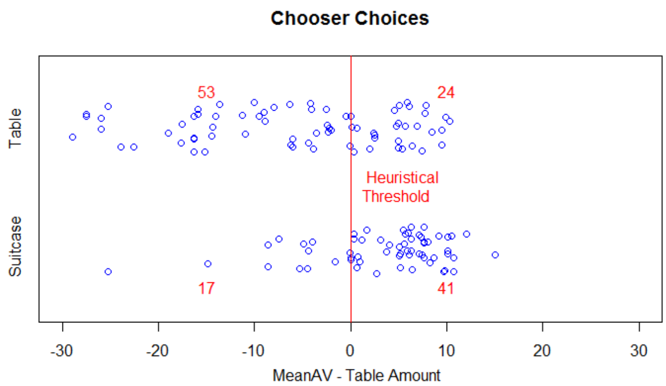
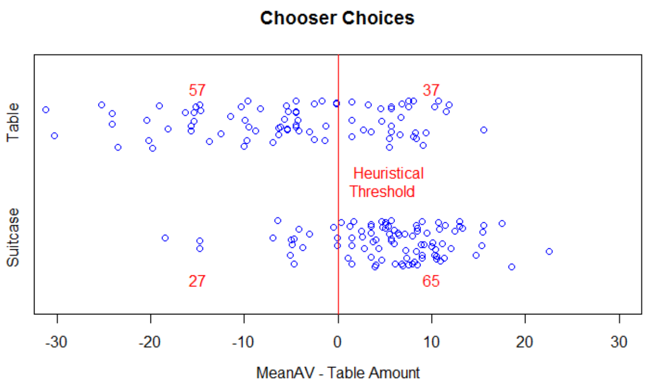


Figure 84: Chooser Heuristics: Mean AV with never AVs

[81] We remind the reader that this is also the prediction for profile 2 (i.e. risk neutral level one Choosers; and the risk averse Nash) for which we already indicated a decent fit with behaviour.



The heuristic seems valid in scenarios with AVs but also does a decent job in scenarios without AVs and scenarios with never AVs (see Figure 82, Figure 83 and Figure 84). This may mean that something else is in play since AV-knowledge is required to use the average AV as a heuristical threshold[82]. To confirm our suspicions we next explored whether a fixed value threshold could explain behaviour. Concretely, we used the (non-disclosed) average of all the distribution amounts in their experimental frequency as a constant decision threshold. Thus, if more than 25.5 tokens are placed on the Table (i.e. Table > 25.5) then the Table should be chosen whilst the Suitcase should be chosen if less than 25.5 tokens are on the Table (i.e. Table < 25.5) (see Figure 85, Figure 86 and Figure 87).

Figure 85: Chooser Heuristics: Constant Threshold with AVs

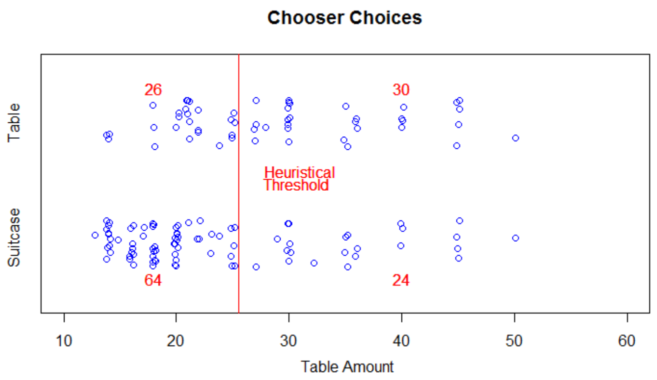


Figure 86: Chooser Heuristics: Constant Threshold without AVs

[82] It may be for example that our values are too similar to one another to distinguish between different threshold values.

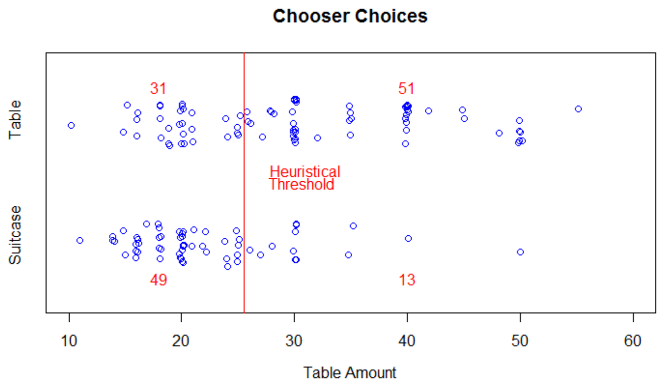
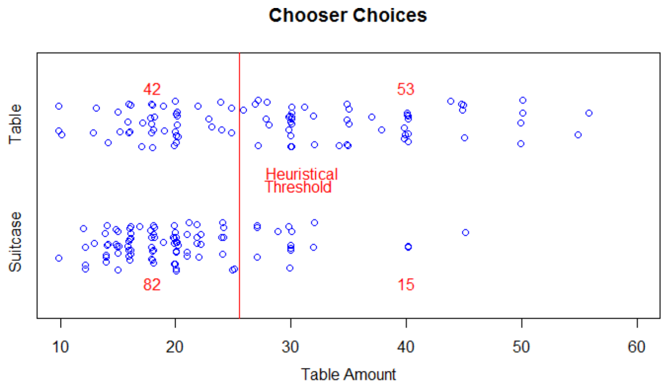


Figure 87: Chooser Heuristics: Constant Threshold with never AVs



This constant threshold does not appear too effective in scenarios with AVs (which can be explained by the AVs providing better ways to assess whether the table amount is large besides its 'naked' value) but appears effective in scenarios without AVs and scenarios with never AVs.

A final attempt to explain behaviour through heuristics relates to previous outcomes. We thus explored whether the best outcome (i.e. Table versus Suitcase) from the last trial played as Splitter (or Chooser) affects the current decision. We omitted trials in which no prediction can be made (i.e. the first trial cannot use the 'previous' trial to base decisions on). First, we look at trials for which the heuristic looks at the previous trial (i.e. played as Splitter) and afterwards we explore the heuristic that looks at two trials ago (i.e. the last trial played as Chooser). Our heuristical threshold for both scenarios is the difference between the Table and Suitcase amount in the predictive trial. If the Table was better (i.e. Table – Suitcase > 0) then we simply expect a preference towards the Table on the current trial; if the Suitcase was better (i.e. Table – Suitcase < 0) then we expect a preference towards the Suitcase on the current trial. First we look at the heuristic that uses the last trial to base predictions on (see Figure 88, Figure 89 and Figure 90).

Figure 88: Chooser Heuristics: Last trial with AVs

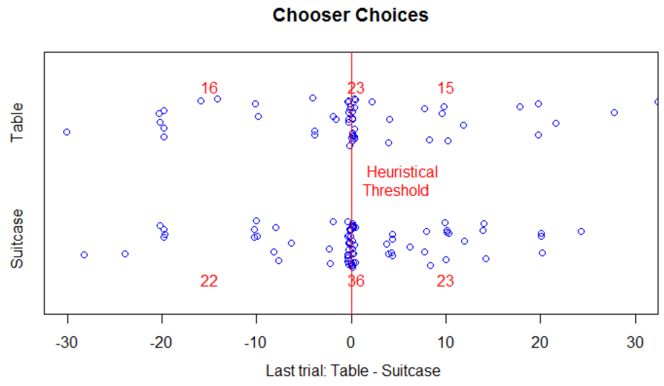


Figure 89: Chooser Heuristics: Last trial without AVs

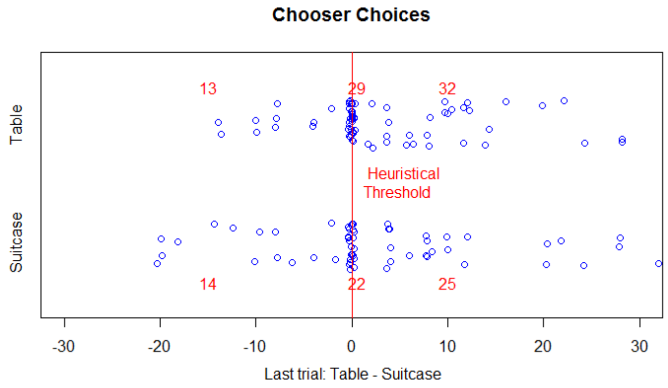
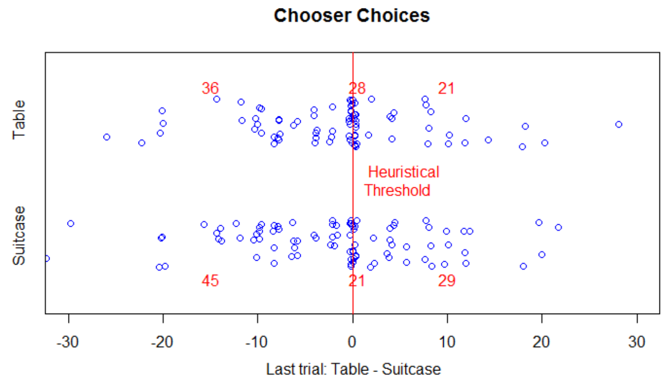


Figure 90: Chooser Heuristics: Last trial with never AVs



The expected effect from the last trial played does not appear to be present in neither of the three conditions. Finally, we assess the same idea looking at the last trial played as Chooser (i.e. data from two trials ago) (see Figure 91, Figure 92 and Figure 93).

Figure 91: Chooser Heuristics: Two trials ago with AVs

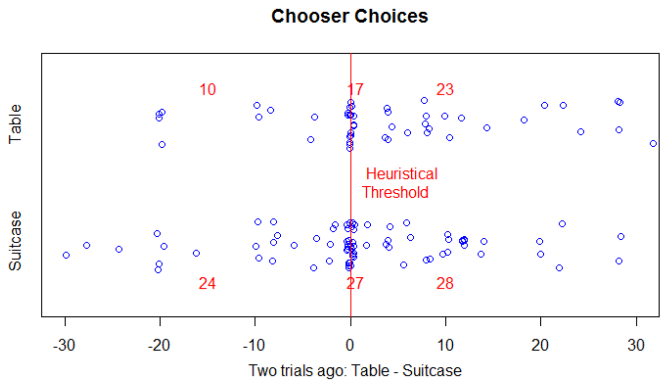


Figure 92: Chooser Heuristics: Two trials ago without AVs

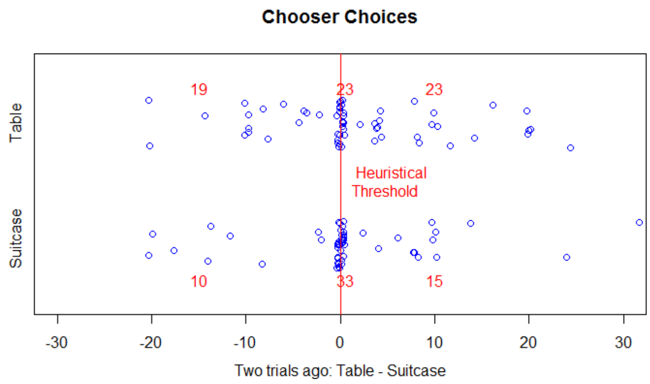
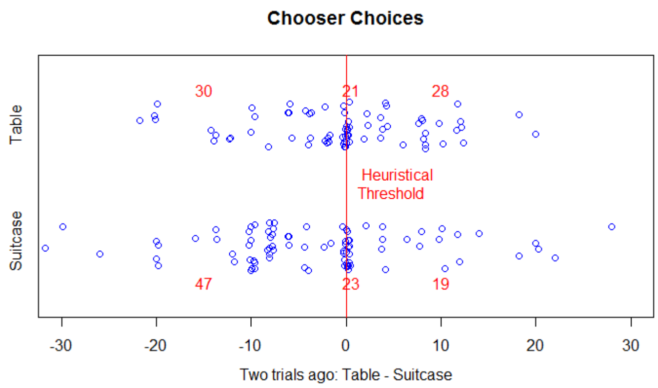


Figure 93: Chooser Heuristics: Two trials ago with never AVs



This heuristic also does not appear to hold true (except perhaps in the Never AVs condition).

Conclusion

We conclude that behavioural predictions from Nash, level k and maximin are quite complex for our experimental game. The most straightforward prediction (which is also observed quite frequently) is that the Splitter should make equal divisions. Observed behaviour suggests that equal divisions are made more frequently when AVs are provided compared to a context without AVs (which supports hypothesis one). Meanwhile, we also find differences between experimental behaviour when the small versus large amount is divided suggesting trickery attempts (which contradicts hypothesis two). Regarding the distance between AVs we do not find a behavioural effect of distance (which supports hypothesis three) which suggests that future variations of the experiment do not need to include a distance variable. For Choosers we conclude that it is extremely hard to assess predictions from theories and models since they are either too precise or they simply suggest that mixed strategies are used in every scenario (which can be hard to assess) or that subjects would behave randomly. Behaviour is generally in line with dominance and in scenarios without dominance behavioural patterns appear consistent with strategy profile 2 (i.e. risk averse Nash predictions and risk neutral level one predictions). We explored whether heuristics are viable at predicting Chooser-behaviour. There may be value in further exploring threshold heuristics; however, past-trial heuristics do not appear successful. Additionally it is worth noticing that the mean AV-heuristic also does a decent job in scenarios *without* AV-knowledge (where the heuristic cannot logically be used); this suggests that the tendencies found from our heuristics may be due to indirect influences of other factors. Furthermore, this heuristic overlaps with strategy profile 2 which makes it hard to assess whether behaviour is really in line with a specific framework or whether it is simply an artefact of our experimental setup. Extreme caution should be employed given that theoretical adherence may be an artefact in designs similar to the Suitcase Game. A verbal protocol setup may be extremely useful to further explore how Choosers make their decisions.

Chapter 5: Implications and future directions

Many real life scenarios involve information, uncertainty and conflicting interests. Advertisements try to sell things, stores try to nudge you with discounts on selected products, and even social card games such as “Werewolves of Millers Hollow” have players attempt to fool those on opposite teams. It is difficult to know which choice will lead to the best outcome and due to the competitive context you cannot rely on the information that is given to you. Still, we are all susceptible to the advertisements we see in daily life, the discounts we find in stores and players can deceive us with convincing arguments. Our experiments explore more deeply in the nature of these scenarios and wonder how and why certain tactics work whilst others do not. Each of our experiments helps fill in the gaps between bargaining scenarios of perfect information and no information. Past literature explored the effects of adding uncertainty to Ultimatum Games (e.g. Mitzkewitz and Nagel, 1993; Rapoport, Sundali and Seale, 1994; Croson, 1996) whilst our own experiments look at Cake Cutting Games with uncertainty surrounding the alternatives. Our games aim to be realistic and intuitive for participants with a close relationship to real life bargaining scenarios.

In the Envelope Game we explored how much risk people are willing to take when they encounter uncertainty and cannot make an informed choice. Would participants make a value transfer when they know nothing about the Closed Envelope (i.e. where they can transfer tokens to) even when the Opened Envelope has a small amount? In the Transfer Game we provide enough information to the first player for making informed decisions; however, we heavily restrict his choice options. Furthermore, we explore reasoning through verbal protocols. Finally, in the Suitcase Game we explore the influence of background knowledge on decisions. How are choices affected by the knowledge of a minimum and maximum value (which have equal probabilities)? This type of question has previously been explored in games against nature through lottery-games, however, everything changes when the opponent is a rational agent. If you are to choose between 23 tokens on the table and a suitcase which has either 17 or 37 tokens in it; then your choice in a context against nature is defined by your risk attitude and the expected values. However, versus a strategic agent you need to consider the possibility of psychological ‘traps’.

A number of ideas can be explored in future research. Generally speaking, we suggest a broader usage of verbal protocols (in experimental pilots at least) to have a better understanding regarding the logic underlying experimental decisions and to realise potential shortcomings of the design. For each of our games we suggest a few variations which could be interesting to explore.

5.1 Envelope Game

One strain of the literature is concerned with topics of ‘voluntary disclosure’. A typical topic used in this literature involves restaurant hygiene notices. Restaurant choice is significantly affected by these food inspection notices (Henson et al., 2006) but disclosure of these notices remains a voluntary choice. Experimental disclosure games can appear somewhat odd and may lack realism for participants. For example, in Jin, Luca and Martin (2015) participants are either senders or receivers. Senders observe a state ‘S’ (which is a number between 1 and 6) and their task is to decide whether to (truthfully) reveal this value to the receiver. The receiver then makes a ‘guess’ regarding the value of ‘S’. Central is in this game is that senders desire that the receiver makes high guesses (as that maximizes the payoff for senders) whilst receivers desire to make accurate guesses (to maximize their own payoff). However, the envelope game can be modified to explore these topics from a somewhat different angle (and arguably be easier to understand). Concretely, instead of transferring value between envelopes the Opener’s task can be reframed as ‘revealing’ a desired amount of value. Such a design is less risky for the Opener since the expected value of the two envelopes remains the same even when he reveals value. Furthermore, revealing any amount below the EV should not affect P2’s behaviour as it is simply ‘cheap talk’[83] – however, it is easy to foresee that this may not be the case in an actual experiment. Furthermore, this “Revealing Game” allows more freedom to Openers since revealing three coins is less risky than a one-coin transfer in the Envelope Game (i.e. in either game P2 is certain that three coins are found in a specific envelope but the difference is that the revealing game does not change the value of the envelopes). Such a variation can be of interest both for comparisons with the base game but also to explore disclosure behaviour in a

[83] Unless he reveals a value larger than the expected value P2 is none the wiser whether 0, 1, 2 or 3 coins are revealed.

different context. Restaurants with a low hygiene rating may choose not to disclose their rating out of fear (of scaring costumers away) whilst restaurants with a high rating are more likely to display (to lure in costumers). The predictions for the Revealing Game variation are the exact opposite: one would want to reveal a small looking amount (i.e. give a bad impression) when a large value is found in the OE whilst revealing a large looking amount (i.e. give a good impression) when a small amount is found in the OE. Other interesting ideas that can be explored from this variation relate to exact revelations: since it is common knowledge that each envelope has a minimum of two coins there is clearly no additional value in revealing zero versus one versus two coins – however, these amounts may be revealed depending on the concrete value in the OE. Similarly, it would be quite curious if Choosers react differently if zero coins are revealed versus two coins given that both scenarios consist of the exact same lack of knowledge – however, this may well be a common finding for such a variation.

Another variation would be to play the game as a Opener versus nature (i.e. versus a randomly deciding Chooser). Past experiments on decisions under uncertainty only look at choices against nature whilst our game involves choices against a rational agent. This variation would help bridge the gap between our novel game and the existing literature on decisions under uncertainty. It allows us to explore whether the same choices are made versus nature and versus a strategic agent and if this is not the case we can explore where the differences lie. E.g. when the OE has a small value P1s generally do not want to transfer, however, versus a strategic agent such reluctance can be seen as a signal. Another example is the question whether we would see more attempts to equalize the two envelopes when playing versus a random agent as we saw evidenced in our variation of the risk attitude assessment (an overview of these ideas is found Table 67).

Table 67: Potential variations using the Envelope Game design

	Why this could be of interest
Variation 1: Value revelation (instead of value transfers)	- less risky for P1 - relates to information disclosure literature - trickery is possible and clearly defined - behaviour should not be affected by revelations below the EV - revelation of 0, 1 or 2 coins allow interesting comparisons since they provide the same amount of nil-information
Variation 2: Played versus nature	- allows comparison of behaviour with respect to luck versus strategic opponents - to bridge the gap with literature on decisions under uncertainty

5.2 Transfer Game

For future work regarding the transfer game it should be obvious that replications regarding violations of strong dominance are worthwhile to explore. However, this game allows more than that. One topic of interest is to assess the effect of differential degrees of knowledge. How would the game change if the Chooser does not know the transfer amount and thus the dominance level can only be assessed by the Decider? Would we observe transfer-decisions for all BS-scenarios and no transfer-decisions for all SB-scenarios (i.e. in line with maximin behaviour) or would mind-games occur depending on the transfer amount? Furthermore, another variation can omit the transfer direction for Choosers – again, allowing the Decider to decrease variance without revealing which option contains the better payoff (providing a within-game parameter for risk attitude measurement). Finally, it is possible to omit the knowledge whether the Decider made the transfer (creating a more simultaneous design instead of a sequential design) to assess whether behaviour would relate more strongly to predictions of theoretical frameworks. It seems intuitively that the Chooser would pick DT in such context whilst the Decider would not transfer out of expectation that the Chooser picks DT (in accordance with Nash etc.). If differences are found this would illustrate a finding by Tversky and Kahneman (1975) that participants use ‘prior probabilities’ (in our case: theoretical predictions) correctly when they have no additional information available but that they evaluate things wrongly when additional information is provided. For example, if participants are asked whether a personality description belongs to an engineer or a lawyer they base themselves on the degree to which the description represents the respective stereotypes regardless prior probabilities; without a personality description they use the prior probabilities to make their judgments (an overview of these ideas is found in Table 68).

Table 68: Potential variations using the Transfer Game design

	Why this could be of interest
Variation 1: transfer amount unknown by P2	- simply ommitting this knowledge could strongly affect Decider-decisions - This ommitance should result into a strong Chooser-preference for DT
Variation 2: Transfer direction not known by P2	- This scenario is not interesting from the perspective of Choosers since they can only make random decisions essentially - For Deciders it provides a context in which maximin-behaviour can be fully embraced without risk of receiving the worse payoff due to ‘dominance’
Variation 3: Whether the transfer is made not known	- This variation could make it easier for Choosers to realise that they should pick DT consistently; furthermore, if Deciders realise this they are more likely to opt for ‘never transferring’ strategies in line with Nash predictions.

by P2	

5.3 Suitcase Game

Some variations can be explored on the suitcase design. Firstly, a variation is possible in which a message is send to the P2 (i.e. in line with the ‘cheap talk’ pilot we briefly explored and which can be found in Appendix 3.2). This may provide interesting insights into behavioural tendencies in relation to honesty (i.e. are P1s truthful in their messages and do P2s believe that they are truthful or not). A similar idea has been explored by Gneezy (2005) by comparing three treatments in which the benefits of lying and the harm done to the other player by lying are manipulated. However, perhaps a more playful design (e.g. incorporating suggestive images instead of ‘written lies’) in the constant-sum context of our game may be the best approach for such a variation. This could result in interesting findings regarding consistency of truthfulness (over trials), contexts of truthfulness, and behavioural patterns for selecting specific messages on specific trials. Furthermore, using less explicit ways of expressing untruths may be less unpleasant than written messages.

A second variation of interest explores behaviour in a context where information on potential distribution amounts (i.e. “the distribution amount is either X or Y tokens”) is known solely by the Splitter or Chooser. If only the Splitter has such information then he should behave the same as when he has no information – as he cannot try to trick the Chooser through this knowledge, nor does he need to fear the Chooser’s knowledge. However, we expect that mere exposure to the potential amounts would affect Splitter-decisions nonetheless. Furthermore, if only Choosers were to know the potential distribution amounts then rational Splitters should solely make equal splits as any deviation can lead to a dominant choice for an informed Chooser (e.g. if we place less than half on the table and our distribution amount was the ‘small’ amount, then an informed Chooser would rationally pick the suitcase due to strong dominance). Our expectation is that this behaviour would be observed in such a variation. These same ideas can be explored more deeply when we add in more uncertainty. A variation can be explored in which the Chooser *may* know the potential distribution amounts – but where the Splitter is uncertain about it. Should he risk deviating from equal divisions when he does not know the degree of knowledge that the Chooser holds?

Finally, feedback manipulations can be explored. In our study we provide feedback on both the table and the suitcase amounts regardless what choices are made. However, Van Dijk and Zeelenberg (2007) already illustrated how behaviour is affected by conditional feedback in a non-competitive scene. Their idea can also be explored in our competitive game since it could be nefast for the Chooser if she were tempted by her curiosity for the suitcase value. Another relevant difference with their design is however that the suitcase game involves solely monetary amounts which seem less likely to invoke strong curiosity compared to a mysterious package. Concretely, we can explore how Choosers behave if they only receive feedback on the suitcase amount when they selected the suitcase (an overview of these ideas is found Table 69).

Table 69: Possible variations using the Suitcase Game design

	Why this could be of interest
Variation 1: The Splitter can send a message	- The game could provide an interesting setup for exploration of truthfulness. Trials have a similar underlying structure but this is not so obvious for participants allowing us to assess behavioural patterns regarding bluffing and deceitfullness; potentially using a playfull design with figurative messages
Variation 2: Only one player has AVs	- This could be interesting since it should not affect Splitter behaviour since trickery based on AVs is not possible when Choosers are ignorant of these AVs - Furthermore, when only Choosers know the AVs it becomes hard for Splitters to divide unequally since this may provide a knowledgeable Chooser with a dominant choice option - Another interesting variant on this is when it is ‘uncertain’ whether the other player has this information.
Variation 3: Conditional feedback on choosing the Suitcase	- It is worth assessing whether the findings of Van Dijk and Zeelenberg (2007) also apply in a game versus a strategic agent (compared to a game against nature)

Real world relevance

Finally, we provide the reader with real world scenarios that relate to our experimental games (see Table 70).

Table 70: Relevance to real world scenarios

Game	Real life scenarios	How the game can apply to these scenarios
Envelope	The Envelope Game has potential applications for the literature on voluntary disclosure. The typical example is how restaurants decide themselves whether to display their hygiene ratings to consumers which can affect patronage. Typically, the literature uses complex games to explore this topic; however, a variation on the Envelope Game can explore things in a simplified way.	Concretely, instead of transferring value between envelopes the Opener's task can be reframed as 'revealing' a desired amount of value. Such a design is less risky for the Opener since the expected value of the two envelopes remains the same even when he reveals value. Furthermore, revealing any amount below the EV should not affect P2's behaviour as it is simply 'cheap talk'. Restaurants with a low hygiene rating may choose not to disclose their rating out of fear (of scaring costumers away) whilst restaurants with a high rating are more likely to display (to lure in costumers). The predictions for the Revealing Game variation are the exact opposite: one would want to reveal a small looking amount (i.e. give a bad impression) when a large value is found in the OE whilst revealing a large looking amount (i.e. give a good impression) when a small amount is found in the OE. The logic is that restaurants aim to have consumers choose their restaurant whilst P1 in the Revealing Games aims for P2 to choose the less valuable envelope.
Transfer	Many real life scenarios involve a decision between two uncertain choice alternatives. E.g. which stocks to buy/sell; which restaurant to pick; which holiday package to take. At times we see one of the alternatives being discounted which can influence our final decision. One holiday package may receive a special promotion involving a 'free breakfast'; Stocks X may be at an all time low whilst Stocks Y is at its usual price; and Restaurant A may offer a free bottle of wine when you take their romantic three-course menu on Valentine's day. Some of these scenarios involve natural discounting (e.g. stocks changing value) whilst others may be due to strategic considerations of salesmen (e.g. free breakfast for the Spain holiday). Our Transfer Game looks at the latter scenarios.	The Transfer Game explores the strategic interactions from such scenarios by placing participants in a context where one option is better than its alternative (i.e. 80 versus 40 tokens) but where only the salesperson knows which option is better. The salesperson is faced with the opportunity to discount Option A (which may or may not be the more valuable option) by decreasing its cost with a pre-decided fixed amount – thus making it more appealing to the buyer relative to Option B. Should they perform this discount when Option A is worse than Option B (which only they know); should they perform the discount when Option A is already better than Option B? And how does the pre-decided discount amount affect their decisions? From the perspective of the consumer should they pick the discounted or the non-discounted option knowing that the salesperson has diverging interests from themselves? And how does the discount-amount affect consumers behaviour?
Suitcase	The used car market is a classic example for topics involving information asymmetry. Sellers have more information than buyers and given that buyers are only willing to pay the average market price adverse selection takes place chasing the good cars from the market.	Our own setup approaches things from a somewhat different angle. Stating that buyers don't always consider the average market price when buying a car. They may weigh off their estimate of the car's value and assess whether they rather forego their savings in exchange for the car or whether they rather keep their savings intact and forego the car. Furthermore, we assess the effects of additional knowledge in the shape of two AVs (Additional Values). This corresponds to buyers and sellers having an idea of the minimum and maximum value that the car may have. This limits the risk to some degree and may incentivize "fair play" based on our preliminary findings.

Chapter 6: Conclusion

We started this thesis with a background discussion on the field of behavioural game theory and introduced the reader to three novel games with different degrees of information. These games were contrasted with prior literature and discussed in more detail in their respective chapters. Each of these games is analysed through the viewpoint of three popular frameworks, namely Nash, level k and maximin. Our standpoint is that some of these frameworks require complex calculations to reach decisions – even in these apparently simple games – and that participants are more likely to have a flexible and intuitive approach to these tasks. In each chapter we made comparisons between experimental behaviour and strategy profiles that were defined based on the predictions of our three main frameworks.

We found in the Envelope Game (Chapter 2) that only a minority of participants truly behaves according to the predictions of a specific framework. However, it could be that a combination of frameworks is used across trials (which is also suggested by prior literature, e.g. Colman et al. (2014)). Another topic explored in Chapter 2 is whether experimental behaviour relates to risk attitudes. For P1 we find that risk averseness leads to a desire to transfer more value when large amounts are involved compared to non-aversely coded P1s; for P2 we did not find a behavioural difference in relation to risk attitude.

In our third chapter we used an even simpler experimental game with arguably a very clear structure. However, it remains a big challenge to compute predictions for some of these frameworks. Again, we found evidence that participants do not adhere consistently to predictions of specific frameworks. As a secondary experiment, we modified the design to allow the collection of verbal protocols. This procedure has not been employed too frequently for experimental games even though it provides researchers with a better understanding of motivations and reasoning behind experimental decisions. Findings indicated that participants, indeed, have no strong adherence to the predictions of specific frameworks[84]. Another benefit of verbal protocols is that it provides us with a better insight regarding the limitations of our experimental design. It became apparent that

[84] Though, it can be argued that this variation is limited by the number of trials and by the fact that it involves team decisions (since one can argue that different teammates may potentially adhere to different frameworks). However, we point out that our within-participant data supports the same conclusions.

small transfer amounts were frequently seen as ‘irrelevant’ due to the marginal effect they have on payoffs – even though they allow ‘bluffing’ through signalling. Furthermore, it is extremely interesting to note that dominance was not spotted that easily despite the simplistic nature of the game. Instead of considering it ‘obvious’ that the DT (direction to) option has a better payoff when 30 tokens are transferred (regardless whether the transfer went from 80 to 40 or 40 to 80) this was occasionally considered a ‘potential bluff’ according to the verbal protocol data. Furthermore, such choices were even made in one third of the scenarios involving strong dominance in an SB (small to big) directionality (i.e. none of the frameworks can explain the behaviour for SB-scenarios of strong dominance)[85]. The fact that participants realise dominance most easily in BS (big to small) scenarios of weak dominance – where a transfer results into equal division – also underscores the idea that behaviour may be best explained through the intuitions participants have and the aspects that are considered most ‘salient’ on specific trials (e.g. ‘equality is possible if we transfer!’, ‘it is risky to transfer since we could end up with low payoffs’, ‘making the transfer results into a better minimum payoff’).

Finally, chapter four discussed a game in which the standard theoretical frameworks have quite clear and specific predictions. One of the topics we explored was the effect of additional knowledge. Concretely, we sometimes provide participants with two values (AVs) which set expectations for the minimum and maximum division amount for the trial that is played. As a result P2 could easily make her decisions by using these values as an indicator regarding the relative size of what is offered to her in comparison to the size of the hidden remainder. Without this data, however, frameworks simply predict her to behave randomly. We made comparisons between experimental behaviour and predictions from the three frameworks and we additionally assessed whether P2’s behaviour can be explained through simple heuristics.

[85] Potentially, this could be a result of our small experimental sample but it remains an odd observation nonetheless.

Reference List

Akerlof, G. A. (1970). The market for lemons: quality uncertainty and the market mechanism. *Quarterly Journal of Economics, 84 (3), 488-500*.

Binmore, K. (2007). Game theory: a very short introduction:l (Vol. 173). *Oxford University Press*.

Brown, G. (1951). Iterative solution of games by fictitious play. *Activity Analysis of Production and Allocation*, 13, 374– 376.

Camerer, C. F., Ho, T. H., & Chong, J. K. (2004). A cognitive hierarchy model of games. *The Quarterly Journal of Economics*, 861-898.

Camerer, C., & Thaler, R. H. (1995). Anomalies: Ultimatums, dictators and manners. *The Journal of Economic Perspectives*, *9*(2), 209-219.

Chen, Y., Lai, J. K., Parkes, D. C., & Procaccia, A. D. (2013). Truth, justice, and cake cutting. *Games and Economic Behavior*, *77*(1), 284-297.

Colman, A. M., Pulford, B. D., & Lawrence, C. L. (2014). Explaining strategic coordination: Cognitive hierarchy theory, strong Stackelberg reasoning, and team reasoning. *Decision*, *1*(1), 35-58. doi: 10.1037/dec0000001.

Colman, A. M. (1982). Game theory and experimental games: The study of strategic interaction. *Pergamon Press, Oxford*.

Cooper, D. J., & Kagel, J. H. (2004). Are two heads better than one? Team versus individual play in signaling games. *The American economic review*, *95* (3), 477-509.

Cox, J. C., & Epstein, S. (1989). Preference reversals without the independence axiom. *The American Economic Review*, 79, 408-426.

Croson, R. T. (1996). Information in ultimatum games: An experimental study. *Journal of Economic Behaviour & Organization*, *30*(2), 197-212.

Dohmen, T., Falk, A., Huffman, D., Sunde, U., Schupp, J., & Wagner, G. G. (2011). Individual risk attitudes: Measurement, determinants, and behavioural consequences. *Journal of the European Economic Association*, *9*(3), 522-550.

Duffy, J., & Nagel, R. (1997). On the robustness of behaviour in experimental ‘beauty contest’games. *The Economic Journal*, *107*(445), 1684-1700.

Gigerenzer, G., & Goldstein, D. G. (1996). Reasoning the fast and frugal way: models of bounded rationality. *Psychological review*, *103*(4), 650-669.

Gneezy, U. (2005). Deception: The role of consequences. *The American Economic Review*, *95*(1), 384-394.

Güth, W. (1995). On ultimatum bargaining experiments – A personal review. *Journal of Economic Behavior & Organization*, 27 (3), 329-344.

Güth, W., & Van Damme, E. (1998). Information, strategic behaviour, and fairness in ultimatum bargaining: An experimental study. *Journal of mathematical Psychology*, *42*(2), 227-247.

Henson, S., Majowicz, S., Masakure, O., Sockett, P., Jones, A., Hart, R., Carr, D. & Knowles, L. (2006). Consumer assessment of the safety of restaurants: The role of inspection notices and other information cues. *Journal of food safety*, *26*(4), 275-301.

Hoffman, E., McCabe, K. A., & Smith, V. L. (1996). On expectations and the monetary stakes in ultimatum games. *International Journal of Game Theory*, *25* (3), 289-301.

Holt, C. A., & Laury, S. (2002). Risk aversion and incentive effects. American Economical Review 92, 1944-1955.

Jin, G. Z., Luca, M., & Martin, D. (2015). Is no news (perceived as) bad news? An experimental investigation of information disclosure. *National Bureau of Economic Research*. Working paper 21099. doi: 10.3386/w21099.

Laury, S., Pay One or Pay All: Random Selection of One Choice for Payment (2005). *Andrew Young School of Policy Studies Research Paper Series No. 06-13*.

Luce, R. D. (1986). Response times: their role in inferring elementary mental organization. *New York Oxford University Press*.

Milgrom, P., & Roberts, J. (1982). Limit Pricing and Entry Under Incomplete Information: An Equilibrium Analysis. *Econometrica*, 50(2), 443-459.

Mitzkewitz, M., & Nagel, R. (1993). Experimental results on ultimatum games with incomplete information. *International Journal of Game Theory*, *22*(2), 171-198.

Nagel, R. (1995). Unraveling in guessing games: An experimental study. *The American Economic Review*, *85*(5), 1313-1326.

Post, T., van den Assem, M. J., Baltussen, G., & Thaler, R. H. (2008). Deal or No Deal? Decision Making under Risk in a Large-Payoff Game Show. *The American Economic Review, 98*(1), 38-71.

Rapoport, A., Sundali, J. A., & Seale, D. A. (1996). Ultimatums in two-person bargaining with one-sided uncertainty: Demand games. *Journal of Economic Behavior & Organization*, *30*(2), 173-196.

Research Methods – Verbal Protocols. (n.d.). Retrieved from http://education.stateuniversity.com/pages/2363/Research-Methods-VERBAL-PROTOCOLS.html

Rubinstein, A. (2007). Instinctive and cognitive reasoning: a study of response times. *The Economic Journal*, *117*(523), 1243-1259.

Seale, D. A., & Phelan, S. E. (2010). Bluffing and betting behaviour in a simplified poker game. *Journal of Behavioral Decision Making*, *23*(4), 335-352.

Seidenfeld, T. (2001). Game Theory and its Relation to Bayesian Theory. *International Encyclopedia of the Social & Behavioural Sciences*, p5868-5873. doi: https://doi.org/10.1016/B0-08-043076-7/00435-6.

Simon, H. A. (1972). Theories of bounded rationality. *Decision and organization*, *1*(1), 161-176.

Thaler, R. H. (1988). Anomalies: The ultimatum game. *The Journal of Economic Perspectives*, *2*(4), 195-206.

Tversky, A., & Kahneman, D. (1975). Judgment under uncertainty: Heuristics and biases. In *Utility, probability, and human decision making* (pp. 141-162). Springer Netherlands.

Van den Assem, M. J., Baltussen, G., & Thaler, R. H. (2008). Deal or no deal? decision making under risk in a large-payoff game show. *The American economic review*, *98*(1), 38-71.

Van Dijk, E., & Zeelenberg, M. (2007). When curiosity killed regret: Avoiding or seeking the unknown in decision-making under uncertainty. *Journal of Experimental Social Psychology, 43*(4), 656-662.

Wald, A. (1945). Statistical decision functions which minimize maximum risk. *Annals of Mathematics*, 46, 265-80.

Appendix

Appendix 1: Envelope Game

Appendix 1.1: Computing EV(CE) conditional on each scenario

The computation of $\mathrm{EV}(\mathrm{CE})$ is done in the following way. First, we assess how many coins are spread between the closed envelope (CE) and destroyed envelope (DE). If we found six coins in the OE we know that the CE and DE should total to six coins as well as the overall sum of the three envelopes is twelve coins. Next, we assess the potential scenarios that may occur, knowing that at minimum two coins are found both in the CE and in the DE. Thus the possible scenarios are (a) CE=4, DE=2; (b) CE=2, DE=4; and (c) CE=3, DE=3. Finally, we can compute the probabilities for each of these three scenarios; however, this is not required since the scenarios have a symmetrical structure. The probability of (a) CE=4 and DE =2 equals the probability of (c) CE=2 and DE=4; this is true for each of the possible scenarios implying that we can simply take their mean value to compute EV(CE). In our example where OE=6 we thus expect to find three coins in the CE ($\mathrm{EV(CE|OE=6)}=\frac{4+3+2}{3}$ = 3).

Hence, in a scenario in which OE=6 and where zero coins are transferred $\mathrm{EV}(\mathrm{CE})=3$. When a transfer is made we can compute a new OE value and a new $\mathrm{EV}(\mathrm{CE})$ value by subtracting and adding the transfer amount to the values. For example if one coin is transferred the OE would have ‘5’ coins remaining (i.e. 6 -1 = 5) and $\mathrm{EV}(\mathrm{CE})$ would increase to ‘4’ coins (i.e. 3 + 1 = 4).

Table 71: EV(CE) for each OE-value

OE	EV(CE)
2	5
3	4.5
4	4
5	3.5
6	3
7	2.5
8	2

Appendix 1.2: Computing the probabilities of finding 'x' coins in the OE

In this appendix we explain to the reader how the probability of finding ‘x’ coins in the OE is computed. Since each envelope contains two coins minimum we thus compute the probability of each of the six remaining coins ending up in the OE (i.e. in total there are 12 coins, each of the three envelopes contains minimum two coins; hence, 12 - 2 - 2 - 2 = 6 coins are randomly assigned to the envelopes). In Table 72 we look at all unique ways in which the remaining six coins can be randomly assigned to the three envelopes. We compute in how many ordered sequences the divisions can happen and the final probability of assigning ‘x’ out of six coins to the OE is computed by dividing these amounts by the total number of possible sequences. We use ‘O’ to refer to a coin being placed in the OE; ‘C’ refers to a coin being placed in the CE and ‘D’ refers to a coin being placed in the DE. Each coin can end up in O, C or D and each location is equally likely. Thus there are $(\frac{1}{3})^6$ possible ways of dividing six coins across the envelopes (= $\frac{1}{729}$).

Table 72: Computing the probabilities of finding X coins in the OE

	Unique ways in which we can assign ‘x’ out of 6 coins to the OE	These events can happen in any sequential order, thus we calculate the number of ways in which each of these combinations of O, C and D can occur	Probability
8	6xO + 0xC + 0xD	$\frac{6!}{6!0!0!} = 1$	$\frac{1}{729}$
7	5xO + 1xC + 0xD 5xO + 0xC + 1xD	$\frac{6!}{5!1!}\times 2 = 12$	$\frac{12}{729}$
6	4xO + 2xC + 0xD 4xO + 0xC + 2xD 4xO + 1xC + 1xD	$\frac{6!}{4!2!}\times 2+\frac{6!}{4!1!1!} = 30+30 = 60$	$\frac{60}{729}$
5	3xO + 3xC + 0xD 3xO + 0xC + 3xD 3xO + 2xC + 1xD 3xO + 1xC + 2xD	$\frac{6!}{3!3!}\times 2+\frac{6!}{3!2!1!}\times 2 = 40 + 120 = 160$	$\frac{160}{729}$
4	2xO + 4xC + 0xD 2xO + 0xC + 4xD 2xO + 3xC + 1xD 2xO + 1xC + 3xD 2xO + 2xC + 2xD	$\frac{6!}{2!4!}\times 2+\frac{6!}{2!3!1!}\times 2+\frac{6!}{2!2!2!} = 30 + 120 + 90 = 240$	$\frac{240}{729}$
3	1xO + 5xC + 0xD 1xO + 0xC + 5xD 1xO + 4xC + 1xD 1xO + 1xC + 4xD 1xO + 3xC + 2xD 1xO + 2xC + 1xD	$\frac{6!}{3!2!1!}\times 2+\frac{6!}{4!1!1!}\times 2+\frac{6!}{5!1!}\times 2 = 120 + 60 + 12 = 192$	$\frac{192}{729}$
2	0xO + 6xC + 0xD 0xO + 0xC + 6xD 0xO + 5xC + 1xD 0xO + 1xC + 5xD	$\frac{6!}{6!}\times 2+\frac{6!}{4!2!}\times 2+\frac{6!}{5!1!}\times 2+\frac{6!}{3!3!} = 2 + 30 + 12 + 20 = 64$	$\frac{64}{729}$

	0xO + 4xC + 2xD 0xO + 2xC + 4xD 0xO + 3xC + 3xD		

As a final test we check whether the sum of our probabilities equals one $\frac{1+12+60+160+240+192+64}{729}=1$.

Appendix 1.3: How the CE is generated in the experiment in relation to the OE

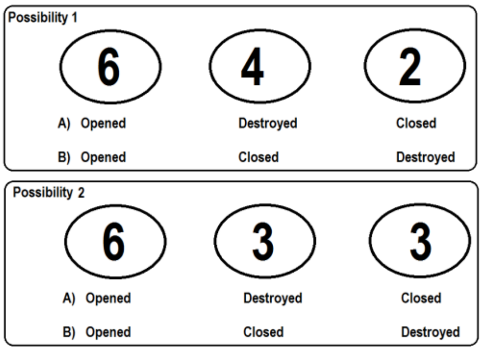
Table 73 summarizes which amounts can be found in the CE when any specific value is observed in the OE. Note that some values are more likely to be in the CE (written in bold). This is because the content of the CE also depends on the content of the DE.

Table 73: How the value of the CE is computed

Content OE	Possible Values CE
8	2
7	2 /3
6	2 / **3 / 3** / 4
5	2 / 3 / 4 / 5
4	2 / 3 / **4 / 4** /5 / 6
3	2 / 3 / 4 / 5 / 6 / 7
2	2 / 3 / 4 / **5 / 5** / 6 / 7 / 8

The content of the CE is decided by randomly drawing one of the numbers from the corresponding cell of the table. See Figure 94 for an example in which the opened envelope contains 6 coins.

Figure 94: Example of CE-value Computation when the OE contains six coins



In the scenario where the OE contains 6 coins we have four possible values for the CE, namely: 4, 2, 3 or 3. The envelope on the left is the OE in our example[86]. If the middle envelope is destroyed then the envelope on the right becomes the CE (alternative A). The right envelope contains two coins if "Possibility 1" is real and contains three coins if "Possibility 2" is real. If the right envelope is destroyed then the envelope in the middle becomes the CE (alternative B). The middle envelope contains four coins if "Possibility 1" is real and contains three coins if "Possibility 2" is real.

Appendix 1.4: Instructions for participants

This appendix provides an overview of the instructions received during a PowerPoint introduction to the experimental task. We point out to the reader that we referred to the P1-role as 'Splitter' and the P2-role as 'Chooser' during the experiment (compared to the terminology of 'Opener' that is used for P1 within Chapter 2).

Slide 1: Title with three envelope images

Hello everyone, today we are playing the envelope game. I will explain the task using a PowerPoint presentation. At the end of the presentation you can ask questions if anything is unclear. Now, first I will explain how things work.

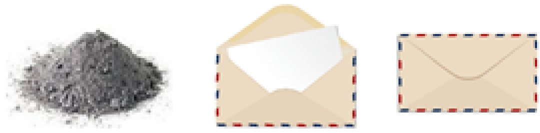
Slide 2: Three envelopes

Each trial starts with three envelopes. And each of these envelopes contains a number of valuable 'coins'.

Slide 3: Destroyed, Opened and Closed Envelope

On each trial one of these three envelopes will be destroyed. It will be burned to ashes as in the image. A second envelope will be opened and the final envelope remains closed. We thus refer to the three envelopes as a Destroyed, Opened and Closed Envelope.

[86] Note that the same outcome would be found if the middle or right envelope were to be opened and contained 6 coins.



Slide 4: Trials

You will be playing 20 trials. Each trial you are randomly matched with another player. One of you will be the Splitter (first player) whilst the other is the Chooser (second player). At the end of each trial you receive feedback on your performance; and your role will change for the next trial. Thus, if you start off as Splitter you then become a Chooser, Splitter, Chooser etc.

Slide 5: Splitter tasks

In each trial, the Splitter's task is to first destroy one of the three envelopes. This is done simply by clicking the button below one of the envelopes. This should not take long (you can just randomly select one of the envelopes). For example you pick the envelope on the right.

Slide 6: Splitter tasks (b)

The corresponding envelope is then burned to ashes (destroyed) without revealing its content. Next, the Splitter is asked to open one of the two remaining envelopes. Again, you can randomly select an envelope. In our example we open the envelope in the middle. We are now informed of the content of the opened envelope. In our example the envelope contains 999 coins. This is a hypothetical amount of course; and you should not expect to see this amount during the experiment.

Slide 7: make a transfer

Next, the Splitter is asked to provide an integer amount of coins which he wants to transfer from the opened to the closed envelope. This can be any amount he likes, including zero coins or the full value 999 coins. The only requirement is that you type an integer amount of tokens, so nothing like 9.5896 or pi; and that the amount cannot be larger than what is found in the opened envelope.

As example, the Splitter may decide to transfer 123 coins to the closed envelope. Thus, he types '123' into the box and clicks on the 'Continue' button.

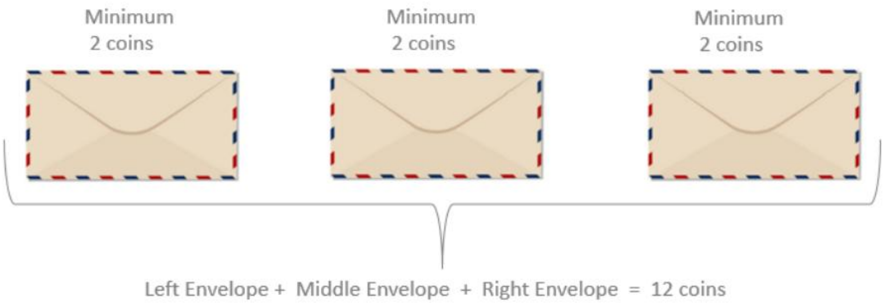
Slide 8: Chooser tasks

Next, we discuss the Chooser tasks. After the Splitter completes his transfer, the Chooser will see how much the Splitter has transferred, for example '123 coins have been transferred from the opened to the closed envelope' (again, this is just an example so don't focus on the numbers too much). The Chooser's task is to decide which envelope he wants for himself by clicking its button.

So if you want the opened envelope you click the button below the opened envelope; if you want the closed envelope you click the button below the closed envelope. Whichever envelope the Chooser selects is given to him as his payoff; and the other envelope is given to the Splitter as his payoff.

Slide 9: Information

Next, I want to go over some background information regarding the three envelopes. First, each of the three envelopes contains at least 2 coins and the sum of coins in the three envelopes is always 12 (i.e. coins in the left envelope plus coins in the middle envelope plus coins in the right envelope sums to 12 coins). This is constant throughout the experiment and will be the case on *every* trial.



Slide 10: payment

Now, the payment. For participating to the experiment you receive a participation fee of two pounds and additionally you receive a performance fee based on the amount of coins you earned in a randomly selected trial. We do not take the average performance in account; we only look at one trial. The performance fee can be anything between zero and twenty pounds. It is worth knowing that each coin in the experiment is worth exactly two pounds[87].

Slide 11: Final notes

Before we start the experiment I will summarize some of the main points of the game.

The game involves some background knowledge. Splitters know the content of the opened envelope (but they do not know the content of the closed or destroyed envelopes). The Chooser does not know the content of any of the three envelopes. Furthermore, both players know that at the start of each trial each of the three

[87] We decided to reveal this to participants from the start. This is not known in our other two experiments.

envelopes contains at minimum two coins and that the three envelopes always sum together to exactly twelve coins.

Finally, I want to stress that the Splitter can transfer coins from the opened to the closed envelope. This is always in this direction – opened to closed – and he decides upon the transfer amount. This can be zero, the full value or any integer amount in between. Furthermore, the Chooser knows how many coins are transferred. The task for the Chooser is to decide whether he wants to closed or opened envelope for himself. And the unchosen envelope is given to the Splitter.

Are there any questions?

Appendix 1.5: Risk Attitude Measurements

Risk attitude is measured in two ways. Firstly there is a hypothetical scenario in which two envelopes contain money. The player decides whether to transfer coins from the Left Envelope to the Right Envelope. However, the player now knows that the Left Envelope contains eight coins and the Right Envelope contains four coins. Furthermore, they play against a random computer opponent (and are aware of this). With this measurement we assess whether participants are risk avoidant (i.e. transfer 1, 2 or 3 coins to decrease the variance), risk neutral (i.e. do not transfer any coins) or risk seeking (i.e. transfer more than 3 coins hence increasing the variance)[88]. One benefit of this assessment is that it is quite close to the experimental game.

The second measurement of risk attitude is more cannon. We offer participants the choice between a lottery ticket with a certain likelihood of winning £10 versus a fixed amount. After every choice the fixed amount changes until we have an accurate picture of the indifference point for each subject. We repeat this set-up twice by changing the likelihood of winning the £10 to draw a more nuanced picture. Our Lottery assessment is based on the most frequently coded risk attitude across the three lotteries. The tables below provide an example of how we assessed risk attitude if the lottery ticket has a 50% chance of winning £10.

Table 74: Lottery ticket has 50% chance to win £10: example risk neutral

[88] In case a subject transfers 4 coins we also flag this, as it comes down to the same scenario as doing nothing. It makes them sound confused (if this occurs it is referred to as "Confused/Neutral").

Lottery Ticket	Fixed Value On Offer	Choice Subject
50% chance £10 50% chance £0	£6.5	Fixed Value
50% chance £10 50% chance £0	£6	Fixed Value
50% chance £10 50% chance £0	£5.5	Fixed Value
50% chance £10 50% chance £0	£5	Fixed Value
50% chance £10 50% chance £0	£4.5	Lottery
50% chance £10 50% chance £0	£4	Lottery

The subject in this example has his indifference point between £5 and £4.5 (estimate: £4.75). The expected value of the lottery is £5. Given that our fixed values differ from each other by £0.5 increments we will consider the subject to be risk neutral. His indifference point lies at the expected value of the lottery. Similarly, if his indifference point was situated between £5 and £5.5 (estimate: £5.25) we would still consider him risk neutral.

Table 75: Lottery ticket has a 50% chance of winning £10: example risk averse

Lottery Ticket	Fixed Value On Offer	Choice Subject
50% chance £10 50% chance £0	£5.5	Fixed Value
50% chance £10 50% chance £0	£5	Fixed Value
50% chance £10 50% chance £0	£4.5	Fixed Value
50% chance £10 50% chance £0	£4	Fixed Value
50% chance £10 50% chance £0	£3.5	Fixed Value
50% chance £10 50% chance £0	£3	Lottery

The subject in this example has his indifference point between £3.5 and £3 (estimate: £3.25). The expected value of the lottery is £5. Since the subject does not want to take the lottery until the fixed amount becomes too minimal we consider him to be risk avoidant. They prefer a small fixed value over a risky lottery with a higher expected value.

Table 76: Lottery ticket has a 50% chance of winning £10: example risk seeking

Lottery Ticket	Fixed Value On Offer	Choice Subject
50% chance £10 50% chance £0	£6.5	Fixed Value
50% chance £10 50% chance £0	£6	Lottery
50% chance £10 50% chance £0	£5.5	Lottery

50% chance £10 50% chance £0	£5	Lottery
50% chance £10 50% chance £0	£4.5	Lottery
50% chance £10 50% chance £0	£4	Lottery

The subject in this example has his indifference point between £6 and £6.5 (estimate: £6.25). The expected value of the lottery is £5. Since the subject prefers the risky lottery over a fixed amount of money even though the expected value of the lottery is lower than the amount on offer we consider him to be risk seeking. He prefers a risky gamble over a certain amount despite the expected value of the gamble being lower.

Appendix 1.6: Specifics as to how lottery questions are administered

In this section we explain how the array of fixed values is created to assess risk attitude through lottery questions. First, a list is defined in which all possible fixed values are stored. This list contains the following values: 0, 0.5, 1, 1.5, 2, 2.5, 3, 3.5, 4, 4.5, 5, 5.5, 6, 6.5, 7, 7.5, 8, 8.5, 9, 9.5, 10, 10.5, 11. Next, the subject chooses between a Lottery Ticket with a certain probability (e.g. 80%) of winning £10 and a Fixed Value of £5. We start by offering the fixed value of £5 but afterwards we randomly sample from the remaining values from our list. We exclude values that are more extreme than the current fixed value (as we assume them to result into the same choice behaviour) but we do not exclude the closest value to account for potential *trembling hand* phenomena. The reason why we randomly sample from the remaining values instead of a constant incremental procedure is to avoid sequence effects. Similarly, we always start with the fixed value of £5 to minimize anchor effects due to starting off with a more versus less extreme value.

Numerical Example of Procedure:

If you prefer a Lottery Ticket with a certain probability (say 80%) of winning £10 over a fixed amount of £5, then we exclude all the fixed amounts below £4.5 from our list by extrapolating that “the lottery would still be preferred if the fixed amount were smaller”. We do not remove the fixed amount of £4.5, however, as we want to ascertain that choices are not due to a “trembling hand”. The list now becomes: 4.5, 6, 6.5, 7.5, 8, 8.5, 9, 9.5, 10, 10.5, 11. Since we already asked the preference when the fixed amount is £5 this value has also been excluded from the list. Next we randomly sample a value from the list; for example, we ask the subject whether they prefer the Lottery Ticket (with the same 80% probability of winning £10) over the new Fixed Value of £9. The subject indicates that they prefer the fixed value of £9. We extrapolate that a fixed value of £10, £10.5 or £11 would also be preferred over the lottery ticket as these are more extreme choice options. We still keep the fixed value of £9.5 in our list in case of a "trembling hand". Our list is now reduced to: 4.5, 6, 6.5, 7.5, 8, 8.5, 9.5. Our next sampling gives us the fixed amount of £7.5. The subject prefers the Lottery Ticket and thus we extrapolate that our subject would also prefer the lottery ticket if the fixed value was £4.5, £6 or £6.5. We would include £7 in our list if it was still available, but this value has already been accounted for in past trials. The new list is: 8, 8.5, 9.5. We now sample whether the subject prefers the lottery or a fixed value of £8. He prefers the fixed value. We exclude £9.5 from our list by extrapolation.

Only £8.5 is left to enquire about. This should logically also result into a preference for the Fixed Value given that both £8 and £9 have this preference already. Our hypothetical subject indeed prefers the fixed value as we expected. If it were the case that he preferred the Lottery over a fixed value of £8.5 then we would have placed a "flag[89]" in our analysis that the subject did something "odd" in the lottery. We would code him as "NA" on this trial as his data may be invalid given that he made odd choices.

Table 77: Preferences in a numerical example

Lottery Ticket	Fixed Value On Offer	Choice Subject
80% chance £10 80% chance £0	£5	Lottery
80% chance £10 80% chance £0	£9	Fixed Value
80% chance £10 80% chance £0	£7.5	Lottery
80% chance £10 80% chance £0	£8	Fixed Value
80% chance £10 80% chance £0	£8.5	Fixed Value.

Given our numerical example above, we compute the indifference point for our hypothetical subject to be between £7.5 and £8 (i.e. the point where his

[89] A flag in this context is something to pull attention to a given feature, namely: "this person did something odd".

preference swaps from the lottery to the fixed value). Our indifference estimate is thus £7.75. In this example the Expected Value of the Lottery is £8 and hence we consider the subject to be risk neutral (as his indifference point lies as close as possible to the expected value of the lottery).

Appendix 1.7: Dominant choices and violations against dominance

In this section we discuss scenarios of strong and weak dominance. Table 78 shows that regardless the amount in the OE one should never transfer four or more coins. The maximum remainder in the OE would be four coins whilst the minimum value of the CE would be six coins. A rational P2 would act according to the dominance and pick the better option. Table 79 shows that one should also be careful of transferring three coins as this leads to weak dominance. A three coin transfer can be made when exactly five coins are found in the OE – as the two envelopes would have the exact same content – but is ill-advised in other scenarios due to the weak dominance involved with three coin transfers. P2 would simply pick the CE and receive the better pay-off.

Table 78: Strongly dominant choices

Opened Envelope Initial Amount	Opened Envelope After Transfer	Closed Envelope After transfer
8	4	minimum 2 + 4 = 6
7	3	minimum 2 + 4 = 6
6	2	minimum 2 + 4 = 6
5	1	minimum 2 + 4 = 6
4	0	minimum 2 + 4 = 6
3		
2		

Table 79: Weakly dominant choices

Opened Envelope Initial Amount	Opened Envelope After Transfer	Closed Envelope After transfer
8	5	minimum 2 + 3 = 5
7	4	minimum 2 + 3 = 5
6	3	minimum 2 + 3 = 5
5	2	minimum 2 + 3 = 5
4	1	minimum 2 + 3 = 5
3	0	minimum 2 + 3 = 5
2		

In Table 80 we summarize the trials in which P1 decided to transfer more than three coins (i.e. resulting into strong dominance for P2). In Table 81 we do the same for scenarios in which exactly three coins are transferred (i.e. resulting into weak dominance for P2). However, it is worthwhile to stress that three coin transfers are only erroneous decisions when less than eight coins are found in the OE.

Table 80: When P1 transfers more than three coins

Subject	Trial Number	OE Content	Transfer Amount
3	0	8	5
3	2	7	5
8	1	6	4
8	11	8	7
12	0	4	4
12	10	8	4
21	1	7	7

There were seven trials in which more than three coins were transferred. Generally speaking the same participants made this error twice and this only happened in the first ten (out of twenty) trials that were played implying that learning effects may be involved. Finally, it is worthwhile to point out that P2 made the rational choice of picking the CE in all seven of these cases.

Table 81: When P1 transfers exactly three coins

Subject	Trial Number	OE Content
0	2	4
0	10	8
2	10	8
7	11	8
8	7	7
9	1	8
11	1	8
11	3	7
13	0	4
14	0	4
15	0	7
16	0	7
22	5	8
28	2	5
35	9	8

There were fifteen trials in which exactly three coins were transferred. Seven of these choices involved eight coins in the OE – which is a rational strategy resulting into equal valued envelopes. Eight choices involved less than eight coins in the OE and are thus errors against weak dominance. In one of these fifteen cases P2 made the erroneous choice of picking the OE but all other choices were in line with weak dominance.

Appendix 1.8: Statistical Output from R

In this appendix we provide the reader with the output files from our statistical tests.

Output for Openers

We ran a one-way repeated measures ANOVA to explore the relationship for P1 between the initial OE-value and the transfer amount. This analysis only used data of trials without dominance involved (i.e. decisions in which the transfer amount is less than three tokens) to minimize noise:

Transferamount ~ InitialAmountOE + Error(Subject/InitialAmountOE)

```
Error: ShortenedData$Subject
                                  Df   Sum Sq Mean Sq
ShortenedData$InitialAmountOpened  1 0.02518 0.02518

Error: ShortenedData$Subject:ShortenedData$InitialAmountOpened
                                  Df Sum Sq Mean Sq
ShortenedData$InitialAmountOpened  1  16.12   16.12

Error: Within
                                   Df Sum Sq Mean Sq F value   Pr(>F)    
ShortenedData$InitialAmountOpened   1  14.12  14.117   33.77 1.45e-08 ***
Residuals                         334 139.61   0.418                     
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

We computed effect sizes using the formula for partial eta squared:

$$\eta^2_{partial} = \frac{SS_{effect}}{SS_{effect} + SS_{error}}$$

$\eta^2_{partial}$: 14.12/(14.12+139.61) = 0.092

We also assessed the relationship between decision time and the initial OE-value and transfer amount. Concretely, we recoded decision times for each individual Opener into z-scores after which we ran a two-way ANOVA. Again, we looked at trials without dominance:

*Zscores ~ TransferAmount * InitialAmountOE + Error(Subject/ (TransferAmount * InitialAmountOE))*

```
Error: P1transfernodominance$Subject
                                    Df Sum Sq Mean Sq
P1transfernodominance$TransferLabel  1 0.1149  0.1149

Error: P1transfernodominance$Subject:P1transfernodominance$TransferLabel
                                    Df Sum Sq Mean Sq
P1transfernodominance$TransferLabel  2  9.874   4.937

Error: P1transfernodominance$Subject:P1transfernodominance$InitValue
                                    Df Sum Sq Mean Sq
P1transfernodominance$TransferLabel  2  6.001  3.0007
P1transfernodominance$InitValue      4  3.739  0.9348

Error: P1transfernodominance$Subject:P1transfernodominance$TransferLabel:P1transfernodominance$InitValue
                                                                Df Sum Sq Mean Sq
P1transfernodominance$TransferLabel                              2 0.0906  0.0453
P1transfernodominance$InitValue                                  6 3.0695  0.5116
P1transfernodominance$TransferLabel:P1transfernodominance$InitValue  4 1.1324  0.2831

Error: Within
                                                                 Df Sum Sq Mean Sq F value Pr(>F)
P1transfernodominance$TransferLabel                               2   6.80   3.398   4.378 0.0134 *
P1transfernodominance$InitValue                                   6   2.87   0.479   0.617 0.7165
P1transfernodominance$TransferLabel:P1transfernodominance$InitValue  12  18.21   1.518   1.956 0.0281 *
Residuals                                                       296 229.71   0.776
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

We computed effect sizes using the formula for partial eta squared:

$$\eta^2_{partial} = \frac{SS_{effect}}{SS_{effect} + SS_{error}}$$

η^2_{partial} : 6.8/(6.8+229.71) = 0.0287

η^2_{partial} : 2.87/(2.87+229.71) = 0.012

η^2_{partial} : 18.21/(18.21+229.71) = 0.073

Output for Choosers:

For each of the transfer amounts we observe a preference towards choosing the CE (i.e. the green bars). We ran a repeated measures ANOVA to assess whether there is a relationship between the envelope choice and the transfer amount. We again looked solely at data in which dominance is not involved to minimize noise.

TransferAmount ~ P2decision + Error(Subject/(P2decision))

```
Error: P2transfernodominance$Subject
                               Df Sum Sq Mean Sq
P2transfernodominance$MyPrize  1 0.1598  0.1598

Error: P2transfernodominance$Subject:P2transfernodominance$MyPrize
                               Df Sum Sq Mean Sq
P2transfernodominance$MyPrize  1  2.183   2.183

Error: Within
                                Df Sum Sq Mean Sq F value Pr(>F)
P2transfernodominance$MyPrize    1   0.02  0.0214   0.043  0.836
Residuals                      334 167.51  0.5015
```

We computed effect sizes using the formula for partial eta squared:

$$\eta^2_{partial} = \frac{SS_{effect}}{SS_{effect} + SS_{error}}$$

$$\eta^2_{partial} = 0.02 / (0.02 + 167.51) = 0.00012$$

Next, we converted the decision time of individual Choosers into z-scores to assess whether a relationship exists between the transfer amount, the Chooser's decision and her decision time. Our two-way ANOVA suggests no relationship between the transfer amount and decision time ($F_{2,326}$ =0.564, p=0.569, $\eta^2_{partial}$ =0.003) and no relationship between the chosen envelope and decision time ($F_{1,326}$ =0.123, p=0.726, $\eta^2_{partial}$ = 0.0003)[90].

*Zscores ~ TransferAmount * P2decision + Error(Subject/(TransferAmount * P2decision))*

```
Error: P2transfernodominance$Subject
                                     Df Sum Sq Mean Sq
P2transfernodominance$TransferLabel  1  0.123   0.123

Error: P2transfernodominance$Subject:P2transfernodominance$TransferLabel
                                     Df   Sum Sq Mean Sq
P2transfernodominance$TransferLabel  2 0.09547 0.04773

Error: P2transfernodominance$Subject:P2transfernodominance$MyPrize
                                     Df Sum Sq Mean Sq
P2transfernodominance$TransferLabel  1 0.2747  0.2747

Error: P2transfernodominance$Subject:P2transfernodominance$TransferLabel:P2transfernodominance$MyPrize
                                     Df Sum Sq Mean Sq
P2transfernodominance$TransferLabel  2  1.262  0.6309

Error: Within
                                                                   Df Sum Sq Mean Sq F value Pr(>F)
P2transfernodominance$TransferLabel                                 2   1.01  0.5067   0.564  0.569
P2transfernodominance$MyPrize                                       1   0.11  0.1104   0.123  0.726
P2transfernodominance$TransferLabel:P2transfernodominance$MyPrize   2   0.88  0.4421   0.492  0.612
Residuals                                                         326 292.67  0.8977
```

[90] For completeness we add that there is no interaction effect either ($F_{2,326}$ =0.492, p=0.612, $\eta^2_{partial}$ =0.003).

Appendix 2: Transfer Game

Appendix 2.1: Why physical screen location does not matter

In our experiment we look at each scenario using two different framings. One framing involves a possible transfer from left to right in which the box on the left has 80 tokens; the other framing involves a transfer from right to left in which the box on the right has 80 tokens. At face value these framings should be the same but psychologically subjects may have a bias due to the physical screen location. In the tables below we make the comparison between P1 behaviour (transfer versus no transfer) when the left box contains 80 tokens versus when the right box contains the 80 tokens. These comparisons are made separately for each possible transfer amount (5, 10, 20, 30 and 35) with exactly one observation per participant in BS-scenarios and one observation per participant in SB-scenarios. First, we look at the data for Deciders.

Table 82: Transfer Amount 5

		BS			SB	
		Left=80			Left=80	
		No Transfer	Transfer		No Transfer	Transfer
Left=40	No Transfer	5	6		7	3
	Transfer	4	9		5	9

Table 83: Transfer Amount 10

		BS			SB	
		Left=80			Left=80	
		No Transfer	Transfer		No Transfer	Transfer
Left=40	No Transfer	2	6		7	3
	Transfer	2	14		6	8

Table 84: Transfer Amount 20

		BS			SB	
		Left=80			Left=80	
		No Transfer	Transfer		No Transfer	Transfer
Left=40	No Transfer	3	5		13	5
	Transfer	3	13		1	5

Table 85: Transfer Amount 30

		BS			SB	
		Left=80			Left=80	
		No Transfer	Transfer		No Transfer	Transfer
Left=40	No Transfer	7	5		12	2
	Transfer	3	9		7	3

Table 86: Transfer Amount 35

		BS			SB	
		Left=80			Left=80	
		No Transfer	Transfer		No Transfer	Transfer
Left=40	No Transfer	9	3		11	5
	Transfer	7	5		6	2

We did McNemar chi squared tests for each possible transfer amount to see whether there is a difference between transferring and not transferring when the physical screen location has the bigger box on the left versus the right side. Results are summarized in Table 87.

Table 87: Summary McNemar Chi Squared Tests for Physical Screen Location and P1 Behaviour

	BS (Big To Small)	SB (Small To Big)
Transfer Amount 5	χ^2 = 0.100, df = 1, p = 0.752	χ^2 = 0.125, df = 1, p = 0.724
Transfer Amount 10	χ^2 = 1.125, df = 1, p = 0.289	χ^2 = 0.444, df = 1, p = 0.505
Transfer Amount 20	χ^2 = 0.125, df = 1, p = 0.724	χ^2 = 1.500, df = 1, p = 0.221
Transfer Amount 30	χ^2 = 0.125, df = 1, p = 0.724	χ^2 = 1.778, df = 1, p = 0.182
Transfer Amount 35	χ^2 = 0.900, df = 1, p = 0.343	χ^2 = 0, df = 1, p = 1

Since we did not find any behavioural differences for Deciders based on the physical screen location we can collapse this variable for P1-data. We assessed for Choosers whether the same holds true in the tables below. It is worthwhile to point out that we can only do McNemar tests for P2-data if we keep data separated based on directionality (i.e. BS versus SB); if we separate based on transfer decisions by P1 we would have two paired-observations for Choosers at times. Separation based on directionality can potentially affect choices made by P2 due to indirect effects on Decider decisions (i.e. transfers may be made conditional on directionality and choices by P2 may be made conditional on transfer decisions).

Table 88: P2 and Physical Screen Location for 5 Coins

		BS			SB	
		Left=80			Left=80	
		DT	DF		DT	DF
Left=40	DT	5	8		3	11
	DF	9	2		6	4

Table 89: P2 and Physical Screen Location for 10 Coins

		BS			SB	
		Left=80			Left=80	
		DT	DF		DT	DF
Left=40	DT	8	2		5	6

	DF	4	10		5	8

Table 90: P2 and Physical Screen Location for 20 Coins

		BS			SB	
		Left=80			Left=80	
		DT	DF		DT	DF
Left=40	DT	8	5		6	8
	DF	5	6		6	4

Table 91: P2 and Physical Screen Location for 30 Coins

		BS			SB	
		Left=80			Left=80	
		DT	DF		DT	DF
Left=40	DT	10	5		11	9
	DF	8	1		1	3

Table 92: P2 and Physical Screen Location for 35 Coins

		BS			SB	
		Left=80			Left=80	
		DT	DF		DT	DF
Left=40	DT	12	6		6	11
	DF	5	1		4	3

A summary of the McNemar chi squared tests from these tables can be found in Table 93. We again did not find an effect of the physical screen location on behaviour. One exception is the "SB30" scenario. Most logically the difference with BS30 is due to P1 behaviour (P2 doesn't know directionality) or artefact of small sample size.

Table 93: Summary Chi Squared Tests for Physical Screen Location and P2 Behaviour

	BS (Big to Small)	SB (Small to Big)
Transfer Amount 5	χ^2 = 0.000, df = 1, p = 1	χ^2 = 0941, df = 1, p = 0.332
Transfer Amount 10	χ^2 = 0.1667, df = 1, p = 0.683	χ^2 = 0, df = 1, p = 1
Transfer Amount 20	χ^2 = 0, df = 1, p = 1	χ^2 = 0.714, df = 1, p = 0.789
Transfer Amount 30	χ^2 = 0.308, df = 1, p = 0.579	χ^2 = 4.9, df = 1, p = 0.029
Transfer Amount 35	χ^2 = 0.000, df = 1, p = 1	χ^2 = 2.4, df = 1, p = 0.121

Appendix 2.2: Instructions for participants

This appendix provides an overview of the instructions received during a powerpoint introduction to the experimental task. Note that we referred to the P1-

role as ‘Splitter’ and the P2-role as ‘Chooser’ during the experiment (compared to the terminology of ‘Decider’ used for P1 within chapter 3).

A) Instructions for Experiment Two

Slide 1: Title and image of two boxes

Hello everyone, today we are playing the Transfer game. I will explain the task using a PowerPoint presentation. At the end of the presentation you can ask questions if anything remains unclear. Now, how does the game work?

Slide 2: How the game works

Each trial you see two boxes displayed on the screen. We refer to the left box as Box A and to the right box as Box B. Both of these boxes contain ‘tokens’. Now what are tokens? Tokens are like money, but you do not know their exact value.

Besides the two boxes it is important to point out that there are two roles in this game. You will play both roles equally often and every trial your role changes. On some trials you are In the role of Splitter while on other trials you are in the role of Chooser. If you start as Splitter you then play as Chooser, Splitter, Chooser etc.

The two roles involve different tasks. The Splitter is able to look at the content of the two boxes but the Chooser cannot. However, the Chooser will decide who receives which box as their payoff…

Slide 3: Transfers

Now, what happens on each trial? Each trial the computer will suggest a token transfer. For example: one token can be transferred from Box A to Box B. This suggestion is thus made with a certain direction (From box a to box b or from box b to box a) and with a specific transfer amount specified. The task for the Splitter is simply to decide whether or not this transfer takes place.

Slide 4: Knowledge:

Now what knowledge is available on each trial? Each trial the Chooser knows the direction of the suggested transfer, the amount of the suggested transfer and whether or not this transfer was made by the Splitter. As a relevant sidenote each trial one box will contain exactly 80 tokens while the other box contains 40 tokens. This is known to everyone and this is the case on every trial. However, the Splitter knows which box has the 80 tokens and the Chooser does not know this.

Slide 5: Notes

Some notes about the experiment. Every trial you swap role between being a Splitter versus being a Chooser. You are randomly matched with someone in the opposite role and feedback is provided after every trial. Again, I remind you that the direction and amount of potential transfers is decided by the computer; the Splitter simply decides whether to make the transfer that is suggested.

Slide 6: Payment

Now, payment. The experiment uses tokens as a currency. What are tokens? Tokens are like pounds but you do not know their value. At the end of the experiment the conversion rate from tokens to pounds is revealed. The amount of tokens you earned on a randomly selected trial decides your performance fee. Thus, your payment consists of two parts. A participation fee of two pounds, and a performance fee based on the amount of tokens you earned in a randomly selected trial.

Slide 7: Sequence of events

The overall sequence of events in the experiment is the following. First the Splitter decides whether to make the transfer while the Chooser waits. Then the Chooser chooses between the two boxes. Finally, feedback is provided. Next, I show some examples of how things will look on the computer screen.

(Slide 8-11 are simply “Example screens”)

Are there any questions?

B) Instructions for Experiment Three

Slide 1: Title and image of two boxes

Hello everyone, today we are playing the Transfer game. I will explain the task using a PowerPoint presentation. At the end of the presentation you can ask questions if anything remains unclear. Now, how does the game work?

Slide 2: How the game works

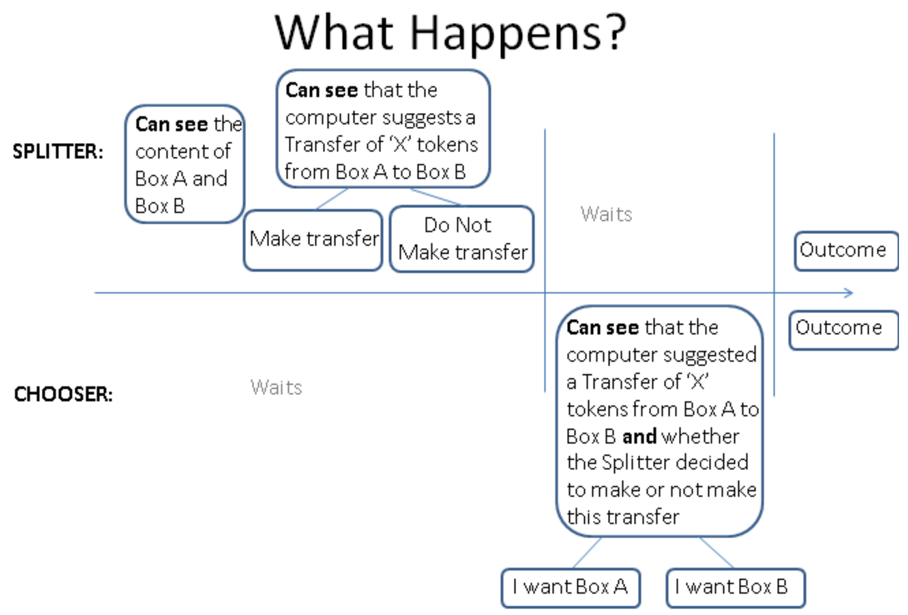
Each trial you see two boxes displayed on the screen. We refer to the left box as Box A and to the right box as Box B. Both of these boxes contain ‘tokens’. Now what are tokens? Tokens are like money, but you simply do not know their exact value.

Besides the two boxes it is important to point out that there are two roles in this game. During every trial you are in one of these two roles; and every trial your role changes. The first role is the Splitter and the second role is the Chooser. If you start as Splitter you next play as Chooser, Splitter, Chooser etc.

Slide 3: What happens

Now, how does the game work? The game starts with the Splitter observing the content of the two boxes. The computer then makes a transfer suggestion. The suggested transfer consists of a transfer direction, left to right or right to left, and a transfer amount. For example X tokens can be transferred from box a to box b. The Splitter’s task is simply to decide whether to make this transfer or not. While the Splitter makes his decision the Chooser waits.

Once the Splitter is done it is revealed to the Chooser that a transfer of X tokens from box a to box b was suggested and whether or not the Splitter made this transfer. The choice for the Chooser is to pick one of the two boxes as his own prize. Finally, you receive feedback. Feedback consists of the prize you won as your payoff (box a or box b) and how many tokens are in this box; furthermore, feedback informs you of the payoff received by the other player (box a or box b) and how many tokens where in this box.

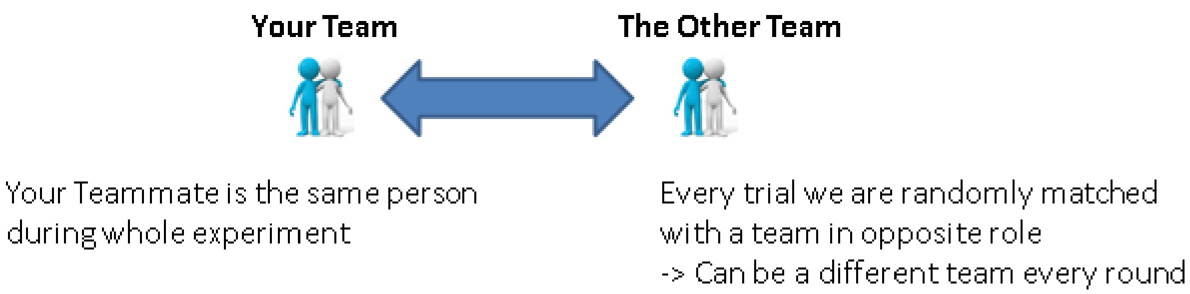


Slide 4: Knowledge

Next, I discuss knowledge. On every trial there is some knowledge available to the Chooser. The Chooser knows the direction and amount for the suggested transfer and whether or not the Splitter made this transfer. Furthermore, every trial one of the two boxes contains 80 tokens whilst the other box contains 40 tokens. Thus, either the left box has 80 and the right box has 40; or the left box has 40 and the right box has 80. But this is constant on every trial.

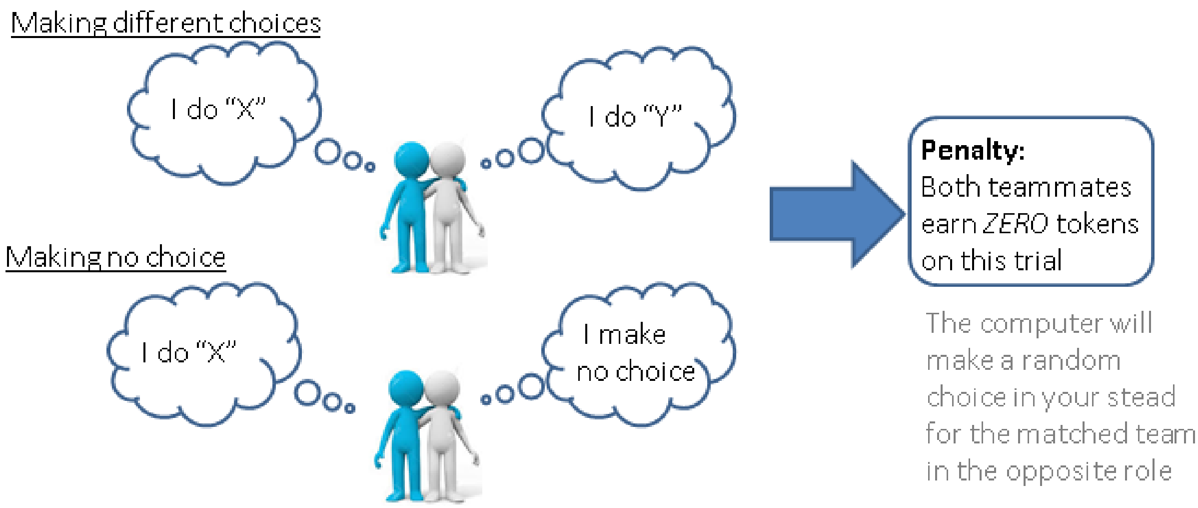
Slide 5: Teams

Next, we discuss teams. During this game you will play in two-player teams. We randomly assign you a teammate; who plays in the same role as you and who sees the same information displayed on the screen. You are either both Splitters or you are both Choosers. This teammate is the same person throughout the experiment and you will communicate with each other through a chatting program. Besides a teammate you are also randomly matched with another team on every trial. The other team plays in the opposite role. Thus, if you are a Splitter team then the other team is a Chooser team. If you are a choose team then the other team is a Splitter team.



Slide 6: Chatting program

In this experiment we use a chatting program to allow you to discuss the task with your teammate. It is extremely important that you and your teammate always make the **same choices**. If you make different choices, for example, one teammate does X while the other teammate does Y; or if a teammate does not make a choice; then a penalty is given. This penalty means that both teammates earn ZERO tokens on the trial that was just played. It is thus important to discuss the task with your teammate and to always make the same choices. Now what happens to the matched team in the opposite role when you get penalized? Whenever a penalty is given the computer makes a random choice in your stead for the matched team that plays in opposite role; it is only your own team that receives a penalty.



Slide 7: Timer

Timers. During each trial you have a time limit to make decisions. A countdown clock is displayed on the screen whenever you make choices. You are given two minutes to make a decision as Splitter team and you are given two minutes to make a choice as Chooser teams. Furthermore, there are fifteen seconds to process the outcomes at the end of the trial during the feedback stage. It is important to know that you can change your decision as long as the timer is running. However, when the timer runs out you cannot change your decision and your choice becomes final. To make it clear that your choice is registered by the computer it is always displayed next to the timer.

Slide 8: Important

Some important notes about the experiment. Firstly, you only chat with your teammate. We do not want you to discuss your identity or your seating location in the lab, etc. You are simply meant to discuss the experimental task. Furthermore, it is important to decide with your teammate before the timer runs out AND to make the same choice to avoid the penalty. This is especially important since there are only six trials in total. Finally, we do not want you to work on any other tasks during the experiment, so no homework, no phones, no papers etc. Please, put all those things away before the experiment starts.

Slide 9: Payment

Now, payment. The experiment uses tokens as a currency. What are tokens? Tokens are like pounds but you do not know their value. At the end of the experiment the conversion rate from tokens to pounds is revealed. The amount of tokens you earn decides your performance fee. So how does payment work? Payment consists of a participation fee of two pounds which you receive simply for showing up and participating and a performance fee between zero and twelve pounds which is based on the amount of tokens you earned in a randomly selected trial. Of course if you are penalized on the trial that is selected you do not earn a performance fee.

Are there any questions?

Appendix 2.3: Behaviour according to theoretical profiles for P1

In this appendix we provide the reader with tables in which we assess the strategy profiles that were suggested by theory. We discuss strong dominance, weak dominance and no dominance in this order. The strategy profiles suggested by theory are refreshed by Table 94.

Table 94: Strategy profiles for P1

	Strategy
Profile 1	Never transfer
Profile 2	BS: transfer SB: no transfer
Profile 3	BS: random SB: no transfer
Profile 4	BS: No transfer SB: Transfer

Table 95: P1s behaviour under strong dominance

	BS		SB	
	Transfer	No transfer	Transfer	No transfer
0	3	1	3	1
1	2	2	0	4
2	2	2	1	3
3	4	0	0	4
4	1	3	1	3
5	2	2	0	4
6	2	2	1	3
7	4	0	1	3
8	2	2	1	3
9	3	1	1	3
10	2	2	2	2
11	0	4	1	3
12	4	0	3	1
13	4	0	1	3
14	2	2	0	4
15	0	4	0	4
16	1	3	2	2
17	2	2	2	2
18	3	1	0	4
19	1	3	1	3
20	1	3	3	1
21	1	3	3	1
22	0	4	3	1
23	0	4	0	4

Allowing slight degrees of trembling hand errors we can categorize five subjects as profile one (purple colours) and five subjects as profile two (i.e. green colours). This means that 60% of participants do not behave according to the strategy profiles suggested by theories in context of strong dominance.

Table 96: P1s behaviour under weak dominance

	BS		SB	
	Transfer	No transfer	Transfer	No transfer
0	2	0	1	1
1	2	0	0	2

2	1	1	2	0
3	2	0	2	0
4	2	0	2	0
5	2	0	0	2
6	2	0	0	2
7	1	1	0	2
8	2	0	0	2
9	1	1	1	1
10	2	0	1	1
11	1	1	0	2
12	1	1	0	2
13	2	0	1	1
14	0	2	0	2
15	2	0	0	2
16	1	1	0	2
17	2	0	1	1
18	2	0	1	1
19	2	0	0	2
20	1	1	2	0
21	0	2	0	2
22	1	1	0	2
23	0	2	2	0

For scenarios of weak dominance we do not have many observations and hence cannot allow trembling hand errors when assessing behaviour according to profiles. We now categorize two participants as profile 1 (i.e. purple colours); five participants as profile 2 (i.e. green colours) and five participants as profile three (i.e. orange colours). 50% of the sample does not behave (fully) according to predictions from our frameworks.

Table 97: P1 behaviour without dominance

	BS		SB	
	Transfer	No transfer	Transfer	No transfer
0	3	1	4	0
1	2	2	4	0
2	1	3	3	1
3	2	2	4	0
4	3	1	2	2
5	1	3	1	3
6	4	0	1	3
7	2	2	3	1
8	3	1	2	2
9	3	1	4	0
10	2	2	1	3
11	2	2	0	4
12	4	0	2	2
13	3	1	1	3
14	4	0	1	3
15	3	1	1	3
16	0	4	2	2
17	4	0	1	3
18	4	0	1	3
19	4	0	1	3

20	2	2	4	0
21	2	2	2	2
22	2	2	3	1
23	4	0	3	1

For scenarios without dominance we observe one participant for profile 1 (i.e. purple colours), seven participants for profile 2 (i.e. green colours), and one participant for profile 4 (i.e. red colours). This means that 63% of participants does not behave according to the suggested profiles for weak dominance.

Appendix 2.4: Behaviour according to theoretical profiles for P2

In this appendix we discuss the behaviour of P2 according to the strategy profiles suggested earlier by theory and models. We discuss in order strong dominance, weak dominance and no dominance. First, we remind the reader how strategy profiles are coded by referring to Table 98.

Table 98: Strategy profiles for P2

	Strategy
Profile 1	Always pick DT
Profile 2	Transfer: DT No transfer: Random
Profile 3	Transfer: DT No transfer: DF
Profile 4	Transfer: DF No transfer DT

Table 99: Strong dominance P2 behaviour

	No transfer		Transfer	
	DF	DT	DF	DT
0	6	0	0	2
1	2	3	0	3
2	2	0	0	6
3	2	3	0	3
4	2	3	1	2
5	3	2	0	3
6	4	3	0	1
7	3	1	0	4
8	1	1	2	4
9	2	2	1	3
10	2	3	1	2
11	2	5	0	1
12	1	3	0	4
13	3	2	0	3
14	1	5	0	2
15	1	5	0	2
16	2	4	1	1
17	2	3	0	3

18	0	0	3	5
19	2	4	0	2
20	2	2	2	2
21	2	4	0	2
22	3	4	0	1
23	3	1	1	3

We coded eight Choosers as adhering to Profile 2 and three Choosers as adhering to profile 1. We do not assess the other profiles since they are only applicable for scenarios without dominance. The majority of Choosers cannot be categorized as strongly acting according to predictions from the suggested frameworks. Note that we even allowed for a slight 'trembling hand' occurrence when categorizing participants.

Table 100: Weak dominance P2 behaviour

	No transfer		Transfer	
	DF	DT	DF	DT
0	2	0	0	2
1	0	2	1	1
2	3	0	1	0
3	0	1	2	1
4	3	0	0	1
5	0	2	0	2
6	0	2	2	0
7	1	1	0	2
8	0	0	2	2
9	0	0	2	2
10	1	0	1	2
11	1	0	0	3
12	1	0	0	3
13	1	0	3	0
14	1	1	0	2
15	1	2	0	1
16	2	1	1	0
17	2	1	0	1
18	2	0	1	1
19	1	2	1	0
20	1	2	1	0
21	0	1	1	2
22	1	1	0	2
23	1	2	0	1

In scenarios of weak dominance we have fewer trials to assess and thus cannot allow for 'trembling hand' phenomena given that each participant only has four trials that can be assessed. Again, we can only assess profile one and profile two and neither of these strongly reflects Chooser-behaviour.

Table 101: No dominance P2 behaviour

	No transfer		Transfer	
	DF	DT	DF	DT
0	1	1	5	1
1	1	2	2	3
2	1	3	4	0
3	1	3	4	0
4	4	1	2	1
5	2	1	3	2
6	2	1	3	2
7	1	0	3	4
8	2	1	0	5
9	2	2	4	0
10	3	2	1	2
11	1	1	5	1
12	2	1	2	3
13	1	1	5	1
14	1	2	1	4
15	0	0	2	6
16	1	5	2	0
17	0	2	2	4
18	2	0	3	3
19	1	2	3	2
20	3	1	1	3
21	1	3	2	2
22	2	4	2	0
23	0	3	3	2

Finally, we look at scenarios without dominance. We can now assess Choosers on four different profiles. Again, we allow for a slight 'trembling hand' occurrence, but nevertheless most participants do not behave according to the predictions of the frameworks that were assessed.

Appendix 2.5: Extensive tables based on P2 behaviour

Within this thesis we assess P1 and P2 behaviour across scenarios. For P1 data is quite compact whilst for P2 there is a multitude of scenarios possible (since the frequency in which P2 faces scenarios is partly dependent on P1's decisions[91]). This appendix provides a detailed summary of P2 behaviour whilst within the paper certain scenarios are merged together (as is required for analysis purposes). Table 102 provides a summary of P2 behaviour in scenarios of strong dominance; Table 103 provides a summary for P2 behaviour in scenarios of weak dominance; and Table 104 provides a summary for scenarios without dominance. Note that the

[91] Concretely, if none of the randomly matched P1-participants make a transfer under weak dominance regardless of the transfer direction then the P2-participant who is matched with them can never face a scenario in which no transfer is made under weak dominance.

transfer and no transfer column in our tables contain exactly one observation for each participant. It is possible for P2 to never face a trial involving a specific dominance level (i.e. strong, weak or no dominance) in which her opponent made a certain decision in which case the participant is coded as ‘0/0’ for that scenario (e.g. she never faced a P1 opponent who made a transfer under strong dominance). Whenever this occurs P2 is coded as ‘unobserved’ and excluded from analysis for that specific scenario. Furthermore, when we merge scenarios for analysis this is done such that all scenarios in which DT > DF are coded as ‘mostly DT’ whilst all scenarios in which DT < DF are coded as ‘mostly DF’. If the two frequencies are equal the subject is coded for that scenario as ‘undecided’. Note that NA-values in the table simply mean that no participant faced this particular ‘DT/DF’ frequency in that scenario.

Table 102: P2 behaviour in scenarios involving strong dominance

DT/DF	Transfer	No Transfer
6/0	1	NA
5/1	NA	2
5/2	NA	1
5/3	1	NA
4/0	2	NA
4/2	1	3
4/3	NA	1
3/0	5	NA
3/1	2	1
3/2	NA	5
2/0	5	NA
2/1	2	NA
1/0	3	NA
1/1	1	1
2/2	1	2
0/2	NA	1
2/3	NA	2
1/3	NA	2
¾	NA	1
0/6	NA	1
0/0	NA	1

Table 103: P2 behaviour in scenarios involving weak dominance

DT/DF	Transfer	No Transfer
3/0	2	NA
2/0	5	3
2/1	2	4
1/0	4	2
1/1	2	3
2/2	2	NA
0/1	4	4
½	1	2

0/2	1	2
0/3	1	2
0/0	NA	2

Table 104: P2 behaviour in scenarios without dominance

DT/DF	Transfer	No Transfer
6/2	1	NA
5/0	1	NA
5/1	NA	1
4/1	1	NA
4/2	1	1
4/3	1	NA
3/0	NA	1
3/1	1	3
3/2	2	NA
2/0	NA	1
2/1	1	3
1/1	NA	3
2/2	1	1
3/3	1	NA
0/1	NA	1
½	1	4
0/2	2	1
2/3	4	1
1/3	NA	1
¼	NA	1
0/4	3	NA
1/5	3	NA
0/0	NA	1

Appendix 2.6: Team play data

Given that Experiment Three is played in teams whilst the initial experiment is played by individuals it is important to realise that choices can be influenced due to the fact that subjects play in a team. In this appendix we provide a summary of choice behaviour for P1 and P2 in both experiments. This offers a rough idea of behavioural differences between the two experiments but the reader should be aware that the data from our third experiment is too scarce to make an adequate comparison between the two experiments. However, the reader should be aware of the small number of observations we have for team-decisions: the comparison between the two experiments should thus be taken lightly.

Table 105: Decision frequencies for P1 as individual

	Big to Small			Small to Big	
	Transfer	No Transfer		Transfer	No Transfer
No dominance	64	32		51	45
Weak dominance	34	14		16	32

Strong dominance	46	50		30	66

Table 106: Decision frequencies for P1 as team

	Big to Small			Small to Big	
	Transfer	No Transfer		Transfer	No Transfer
No dominance	5	4		1	7
Weak dominance	7	2		2	6
Strong dominance	5	2		3	6

The reader should be aware that each row in Table 106 consists of one decision (transfer versus no transfer) made per P1 team – which is either in a BS or in a SB-scenario[92]. Furthermore, data from some teams is missing from this table due to a failure of making an uniform choice within the two minute decision frame (i.e. we cannot use the random decision made by the computer on penalized trials). Concretely; 5 out of 108 choices were excluded due to penalization – four of these were P1 decisions.

Looking at the data of individuals versus teams we observe the following differences for P1. When no dominance is involved (transfer amount 5 or 10) individuals prefer to transfer as BS-type and are indifferent as SB-type whilst teams are indifferent as BS-type and prefer not to transfer as SB-type. When weak dominance is involved (transfer amount 20) both teams and individuals prefer to transfer as BS-type whilst they prefer not to transfer as SB-type. It seems clear from the verbal protocols that most teams realised as BS-type how a 20 token transfer leads to an equal value for either box which they generally preferred; presumably the same realisation occurred for individuals playing this scenario. When strong dominance was involved both teams and individuals prefer not to transfer as SB-type; meanwhile as BS-type we observe indifference between transferring and not transferring for individuals whilst teams displayed a preference towards transferring. We note that the verbal protocols indicated how teams were often pessimistic about the 30 tokens BS-transfer option with the idea that they would receive the smaller value either way (thus they rather decreased the value difference by making the transfer). This may be true for individuals too but cannot be assessed in the current experiment.

[92] Each team faced exactly six trials, three of which are faced as P1 team. Thus out of the six cells from our table each team contributed solely to three of these cells.

Next, we compare P2 decisions as individual versus team.

Table 107: Decision frequencies for P2 as individual

	Transfer			No Transfer	
	DF	DT		DF	DT
No dominance	64	51		35	42
Weak dominance	19	31		25	21
Strong dominance	12	64		53	63

Table 108: Decision Frequencies for P2 as Team

	Transfer			No Transfer	
	DF	DT		DF	DT
No dominance	2	5		7	4
Weak dominance	0	10		3	4
Strong dominance	2	8		3	5

Note that we have one data point per P2 team in each row – either in a scenario where a transfer was made or in a scenario where the transfer was declined. For the weak dominance scenario there is one P2 team excluded from this table due to the penalization rule.

We find that P2 teams are more likely to pick DT whenever a transfer is made compared to individual P2s (including when the transfer amount is small). Furthermore, when no dominance is involved the P2 team picks DT mostly when a transfer is made whilst picking DF mostly when a transfer is not made – suggesting that they assume bluffing behaviour. Individual P2s acts somewhat randomly and displays opposite tendencies. Under weak dominance the behaviour of teams and individuals is roughly the same though teams seem more aware of the weak dominance given that they consistently picked DT whenever 20 tokens were transferred whilst individuals only picked DT slightly more frequent than DF in such a context. Finally, under strong dominance individuals and teams seem to display the same tendencies.

Appendix 2.7: Coding for verbal protocols

In this appendix we describe how the author has coded the verbal protocol data into an assessment for the reasoning process, an assessment whether the team considered bluffing and an assessment whether or not the team recognized dominance when applicable. This appendix will explain in detail which coding options are used and how they are defined.

A) Reasoning: what is the main motivation for the team to make a specific choice?

- **Maximin:** the team motivates their choice as trying to minimize the difference (and thus maximizing their minimum gain).

- **Avoid risk**: the team makes their choice by wanting to avoid risk.

- **Random Guess**: the team has no reason to believe either option should be preferred and thus makes a random choice.

- **No reasoning**: no clear reasoning is provided to base our coding on. The team coordinates on the same decision without need to motivate their preferred choice.

- **Dominance:** the team spots dominance and explains it to their teammate as the reason why they should make a specific choice.

- **Equality**: the team faces a BS20 scenario and decides to transfer as the boxes would be 60-60.

- **Looks at EV**: the team bases its choice on the expected value of the two boxes, thus picking DT when a transfer is made.

- **Considers bluff**: explicit mentioning that the team will try to trick the other team in picking the smaller box.

- **Amount too small**: the team thinks that the amount is too small to be relevant; regardless their choice as Splitter it won't matter much. As Chooser it is not seen as a valid signal as it is too tiny to affect the expected value much.

- **Not coordinated**: the team did not make the same choice.

- **Not on time**: the team did not make a choice in the two minute time limit.

- **Did not understand task**: based on their chat log the team did not understand the task.

B) Bluffing: did the team consider bluffing behaviour?

- **NA**: The team made their choice based upon a line of reasoning not compatible with 'bluffing' logic. They reason according to: avoid risk, maximin, dominance, equality, not on time, not coordinated, did not understand task, looks at EV. Trials that are not coded "NA" on bluffing are categorized based on the scenario that participants face and their decision.

- **Assumes no transfer means DF > DT (bluff)**: The Chooser team faces a no transfer scenario and picks DF. This behaviour suggests that they assume that DF has a larger value than DT which is a 'bluffing' interpretation of P1s behaviour.

- **Assumes no transfer means DT > DF (no bluff):** The Chooser team faces a no transfer scenario and picks DT. This behaviour suggests that the assume that DT has a larger value than DF which is a 'non bluffing' interpretation of P1s behaviour.

- **Assumes transfer means DT > DF (bluff):** The Chooser team faces a transfer scenario and picks DT. This behaviour suggests that the assume that DT has a larger value than DF which is a 'bluffing' interpretation of P1s behaviour.

- **Assumes transfer means DF > DT (no bluff):** The Chooser team faces a transfer scenario and picks DF. This behaviour suggests that the assume that DF has a larger value than DT which is a 'no bluffing' interpretation of P1s behaviour.

- **Decrease variance (no bluff):** The Decider team faces a BS-trial and makes the transfer thus decreasing the variance between the two boxes; or the Decider team faces a SB-trial and refuses the transfer thus not increasing the variance between the two boxes. This behaviour can be seen as a 'non bluff'.

- **Increase variance (bluff):** The Decider team faces a BS-trial and does not make the transfer thus not decreasing the variance between the two boxes; or the Decider team faces a SB-trial and makes the transfer thus increasing the variance between the two boxes. This behaviour can be seen as a 'bluff'.

C) Dominance: did the team spot dominance when the transfer amount is 20 or more?

- NA: the trial involves a small amount (five or ten tokens) implying that there is no dominance to assess.

- Does not spot dominance: based on the chat and choice made by the team they did not seem to realise that dominance is involved if a transfer is made.

- Unclear: the team makes the correct choices and their chat suggests that they may have spotted dominance but no explicit mentioning of dominance as given.

- Spots dominance: the team realised that dominance is involved.

- Spots equality: the team realised that a transfer leads to a scenario where the boxes both contain exactly 60 tokens.

Appendix 2.8: Full overview encoding for reasoning, bluffing and dominance in Experiment Three

Table 109 provides an overview of the verbal protocol encoding following the coding scheme specified in Appendix 2.7. We assess reasoning, bluffing and dominance in the columns whilst the rows represent data of the six trials that are played by each of the eighteen teams. Note that reasoning for amounts five and ten can have a double-coding with 'amount too small' suggesting that the team did not consider the trial worthwhile to put much effort into.

Table 109: Coding For Verbal Protocols

Team	Trial	Role	Scenario	Reasoning	Bluffing interpretation	Dominance
1	0	P1	BS30	Maximin	NA	Does not spot
1	1	P2	SB35 – transfer	Maximin	NA	Does not spot
1	2	P1	SB20	Maximin	NA	Does not spot
1	3	P2	BS20 – transfer	Avoid risk	NA	Does not spot
1	4	P1	BS5	Maximin	NA	NA
1	5	P2	SB10 – no transfer	Random guess	Assumes no transfer means DF>DT (bluff)	NA
2	0	P1	BS30	No reasoning	Decrease variance (no bluff)	Unclear
2	1	P2	SB35 – transfer	Dominance	Assumes transfer means DT>DF (bluff)	Spots dominance
2	2	P1	SB20	No reasoning	Decrease variance (no bluff)	Unclear
2	3	P2	BS20 – transfer	Dominance	NA	Spots dominance
2	4	P1	BS5	No reasoning	Increase variance (bluff)	NA

2	5	P2	SB10 – no transfer	No reasoning	Assumes no transfer means DT>DF (no bluff)	NA
3	0	P1	BS30	No reasoning	Increase variance (bluff)	unclear
3	1	P2	SB35 – no transfer	Random guess	No transfer means DF>DT (bluff)	Does not spot
3	2	P1	SB20	Considers bluff	Increase variance (bluff)	Does not spot
3	3	P2	BS20 – no transfer	Considers bluff	Assumes no transfer means DF>DT (bluff)	Does not spot
3	4	P1	BS5	Considers bluff	Decrease variance (no bluff)	NA
3	5	P2	SB10 – no transfer	Random guess	Assumes no transfer means DF>DT (bluff)	NA
4	0	P2	BS30 – transfer	No reasoning	Assumes transfer means DT>DF (bluff)	Does not spot
4	1	P1	SB35	Avoid risk	NA	Does not spot
4	2	P2	SB20 – transfer	Dominance	NA	Spots dominance
4	3	P1	BS20	Equality	NA	Spots equality
4	4	P2	BS5 – no transfer	Considers bluff	Assumes no transfer means DF>DT (bluff)	NA
4	5	P1	SB10	Maximin	NA	NA
5	0	P2	BS30 – transfer	No reasoning	Assumes transfer means DT>DF (bluff)	Unclear
5	1	P1	SB35	Considers bluff	Increase variance (bluff)	Does not spot
5	2	P2	SB20 – no transfer	No reasoning	Assumes no transfer means DF>DT (bluff)	Does not spot
5	3	P1	BS20	Maximin	NA	Does not spot
5	4	P2	BS5 – transfer	Random guess	Assumes transfer means DF>DT (no bluff)	NA
5	5	P1	SB10	Avoid risk	Decrease variance (no bluff)	NA
6	0	P2	BS30 – no transfer	No reasoning	Assumes no transfer means DT>DF (no bluff)	Does not spot
6	1	P1	SB35	No reasoning	Increase variance (bluff)	Does not spot
6	2	P2	SB20 – no transfer	No reasoning	Assumes no transfer means DF>DT (bluff)	Does not spot
6	3	P1	BS20	No reasoning	Increase variance (bluff)	Does not spot
6	4	P2	BS5 – transfer	No reasoning	Assumes transfer means DF>DT (no bluff)	NA
6	5	P1	SB10	Maximin	NA	NA
7	0	P1	BS30	Not coordinated	NA	Does not spot
7	1	P2	SB35 – transfer	Dominance	NA	Spots dominance
7	2	P1	SB20	Avoid risk	Decrease variance (no bluff)	Does not spot
7	3	P2	BS20 – no transfer	Random guess	Assumes no transfer means DT>DF (no bluff)	Does not spot
7	4	P1	BS5	Amount too small; considers bluff	Increase variance (bluff)	NA
7	5	P2	SB10 – no transfer	Random guess	Assumes no transfer means DT>DF (no bluff)	NA
8	0	P1	BS30	Considers bluff	Decrease variance (no bluff)	Does not spot
8	1	P2	SB35 – no transfer	Considers bluff	Assumes no transfer means DF>DT	Does not spot
8	2	P1	SB20	Considers bluff	Increase variance (bluff)	Does not spot
8	3	P2	BS20 – transfer	Equality	NA	Spots dominance
8	4	P1	BS5	No reasoning	Decrease variance (no bluff)	NA
8	5	P2	SB10 – transfer	Looks at EV	NA	NA

9	0	P1	BS30	Did not understand task		
9	1	P2	SB35 – no transfer	Did not understand task		
9	2	P1	SB20	Did not understand task		
9	3	P2	BS20 – transfer	Did not understand task		
9	4	P1	BS5	Did not understand task		
9	5	P2	SB10 – no transfer	Did not understand task		
10	0	P2	BS30 – transfer	Dominance	NA	Spots dominance
10	1	P1	SB35	Avoid risk	NA	Does not spot
10	2	P2	SB20 – no transfer	Considers bluff	Assumes no transfer means DT>DF (no bluff)	Does not spot
10	3	P1	BS20	Equality	NA	Does not spot
10	4	P2	BS5 – transfer	Looks at EV	NA	NA
10	5	P1	SB10	Not on time	NA	NA
11	0	P2	BS30 – transfer	Did not understand task		
11	1	P1	SB35	Did not understand task		
11	2	P2	SB20 – transfer	Did not understand task (so uses simply heuristic from here on to always pick DT if transfer is made)	Assumes tansfer means DT>DF (bluff)	Does not spot
11	3	P1	BS20	No reasoning	Decrease variance (no bluff)	Does not spot
11	4	P2	BS5 – transfer	Random guess	Assumes transfer means DT>DF (bluff)	NA
11	5	P1	SB10	Maximin	Decrease variance (no bluff)	NA
12	0	P2	BS30 – transfer	Considers bluff	Assumes transfer means DF>DT	Does not spot
12	1	P1	SB35	Avoid risk	NA	Does not spot
12	2	P2	SB20 – transfer	No reasoning	Assumes transfer means DT>DF (bluff)	Does not spot
12	3	P1	BS20	No reasoning	Increase variance (bluff)	Does not spot
12	4	P2	BS5 – no transfer	Random guess	Assumes no transfer means DF>DT (bluff)	NA
12	5	P1	SB10	No reasoning	Decrease variance (no bluff)	NA
13	0	P1	SB20	Dominance	NA	Spot dominance
13	1	P2	SB35 – no transfer	Considers bluff	Assumes no transfer means DF>DT (bluff)	Does not spot
13	2	P1	BS5	Amount too small; maximin	NA	NA
13	3	P2	BS20 – transfer	Dominance	NA	Spots dominance
13	4	P1	BS30	Maximin	NA	Unclear
13	5	P2	SB10 – transfer	Looks at EV	NA	NA
14	0	P1	SB20	Avoid risk	NA	Does not spot
14	1	P2	SB35 – no transfer	Considers bluff	Assumes no transfer means DT>DF (no bluff)	Does not spot
14	2	P1	BS5	Amount too small; no reasoning	Increase variance (bluff)	NA
14	3	P2	BS20 – Transfer	Equality	NA	Spots equality
14	4	P1	BS30	No reasoning	Increase variance (bluff)	Unclear
14	5	P2	SB10 – no transfer	No reasoning	Assumes no transfer means DF>DT (bluff)	NA
15	0	P1	SB20	Avoid risk	NA	Does not spot
15	1	P2	SB35 – no transfer	No reasoning	Assumes no transfer	Does not spot

					means DT>DF (no bluff)	
15	2	P1	BS5	Amount too small; considers bluff	Increase variance (bluff)	NA
15	3	P2	BS20 – Transfer	Equality	NA	Spots dominance
15	4	P1	BS30	Maximin	NA	Unclear
15	5	P2	SB10 – no transfer	Random guess	Assumes no transfer means DT>DF (no bluff)	NA
16	0	P2	SB20 – no transfer	No reasoning	Assumes no transfer means DT>DF (no bluff)	Does not spot
16	1	P1	SB35	Avoid risk	NA	Does not spot
16	2	P2	BS5 – no transfer	Random guess	Assumes no transfer means DT>DF (no bluff)	NA
16	3	P1	BS20	Equality	NA	Spots equality
16	4	P2	BS30 – transfer	Dominance	NA	Spots dominance
16	5	P1	SB10	No reasoning	Decrease variance (no bluff)	NA
17	0	P2	SB20 – no transfer	Considers bluff	Assumes no transfer means DT>DF (no bluff)	Does not spot
17	1	P1	SB35	No reasoning	Decrease variance (no bluff)	Does not spot
17	2	P2	BS5 – no transfer	No reasoning	Assumes no transfer means DF>DT (bluff)	NA
17	3	P1	BS20	Equality	NA	Spots equality
17	4	P2	BS30 – transfer	Dominance	NA	Spots dominance
17	5	P1	SB10	Amount too small; considers bluff	Increase variance (bluff)	NA
18	0	P2	SB20 – no transfer	Considers bluff	Assumes no transfer means DT>DF (no bluff)	Does not spot
18	1	P1	SB35	Avoid risk	NA	Does not spot
18	2	P2	BS5 – transfer	Looks at EV	NA	NA
18	3	P1	BS20	Equality	NA	Spots equality
18	4	P2	BS30 – no transfer	Considers bluff	Assumes no transfer means DT>DF (no bluff)	Does not spot
18	5	P1	SB10	Amount too small; considers bluff	Decrease variance (no bluff)	NA

Appendix 2.9: Raw data from verbal protocols

Below are the chat files from the three sessions we ran using verbal protocols. Each team can talk with their teammate during the whole experiment using chatting software. It is important to point out to the reader that we used the terms ‘Splitter’ and ‘Chooser’ during the experimental sessions to refer to P1 (Decider) and P2 (Chooser) respectively – and that these same terms thus occur in the chatting data instead of the terminology used within this thesis. P1 trials are coded in a green font and P2 trials are coded in a blue font. Now and then we observe lack of task understanding and faulty reasoning which is indicated in red font. Chit-chat is kept in a black font. Note that the chat data is largely kept as it was (i.e. we did not convert chat-speak to clean English) though typos are corrected and small adjustments – such as turning ‘i’ into ‘I’ – were made to improve clarity and readability. Above each dialogue we summarize the data that was collected on the team’s trials. Tables mention whenever a team failed to make a uniform decision in the allotted timeframe by the wording ‘penalty’ as their choice (with the randomly made choice by the computer, in their stead, written between brackets). If the opposing team were penalised it is not mentioned in the table since this is only known at the feedback stage and cannot affect decisions.

Session 1:
Team 1:

Table 110: Scenarios faced by team 1

Trial	Role	Scenario	P1 decision	P2 decision
0	P1	BS30	Transfer	DT
1	P2	SB35	Transfer	DT
2	P1	SB20	No transfer	DF
3	P2	BS20	Transfer	DT
4	P1	BS5	Transfer	DF
5	P2	SB10	No transfer	DF

12:41:49 <Team1B> hello?
12:42:00 <Team1A> Hello
12:42:18 <Team1A> Are we making the transfer?
12:42:26 <Team1B> what do you think
12:42:37 <Team1A> It would give us higher overall as I imagine the other team would pick the higher amount
12:42:47 <Team1A> So we would get 50 instead of 40
12:42:53 <Team1B> then transfer?
12:42:56 <Team1A> I think so
12:42:59 <Team1B> ok
12:43:24 <Team1A> Have done it
12:43:29 <Team1B> me2
12:44:09 <Team1B> I have a question
12:44:16 <Team1A> Okay
12:44:22 <Team1B> are going to be Splitter throughout
12:44:39 <Team1A> No we alternate so next time we will be the Choosers
12:44:58 <Team1B> but we have to pick the same box is that correct?
12:45:15 <Team1A> Yeah we have to make the decision together and make the same choice to avoid getting 0
12:45:25 <Team1B> cool
12:46:43 <Team1B> I think it will be even more interesting if the Choosers don't know the amount
12:47:09 <Team1A> Yeah, maybe they'll do that on another experiment
12:48:41 <Team1B> what do you think
12:48:59 <Team1A> I'm not sure
12:49:07 <Team1B> I think we should choose box b
12:49:22 <Team1B> we know at least we will have 35
((Subject doesn’t seem to pay attention to initial content of 40 minimum in box b…))

12:49:27 <Team1A>	Yeah
12:49:35 <Team1A>	I will choose that now
12:49:42 <Team1B>	ok I will do the same
12:49:53 <Team1A>	Have chosen
12:50:02 <Team1B>	me2
12:50:37 <Team1A>	Nice thinking
12:50:37 <Team1B>	that's a lot
12:51:08 <Team1A>	I say don't make the transfer and then we at least get 40 rather than 20
12:51:08 <Team1B>	what do you think
12:51:18 <Team1B>	this can be a bluff
12:51:28 <Team1B>	but I agree
12:51:32 <Team1B>	let's not transfer
12:51:36 <Team1A>	Agreed
12:51:51 <Team1A>	Have chosen
12:52:03 <Team1B>	me2
12:53:09 <Team1B>	hope they will choose box a
12:53:21 <Team1A>	They might do
12:53:28 <Team1B>	we need to pray
12:53:33 <Team1A>	Haha
12:53:41 <Team1B>	how much are you expecting to earn
12:54:04 <Team1A>	Not sure really, have done these kind of things before and been quite lucky
12:55:07 <Team1A>	Nice
12:55:15 <Team1B>	strange
12:55:23 <Team1B>	prayers work
12:56:00 <Team1B>	I have another question
12:56:05 <Team1A>	Go ahead
12:56:15 <Team1B>	so are we splitting the token?
12:56:22 <Team1A>	No we get it each I think
12:57:44 <Team1A>	What do you think?
12:57:48 <Team1B>	haha
12:57:51 <Team1B>	u did it first
12:58:09 <Team1B>	if box A has more
12:58:16 <Team1B>	then they won't transfer
12:58:26 <Team1B>	or this can be a bluff
12:58:37 <Team1A>	Or would they transfer so that they could have more as a minimum?
12:58:52 <Team1A>	40 seconds...
12:59:04 <Team1A>	Shall we go with Box A?
12:59:05 <Team1B>	it will be risky to pick box A
12:59:10 <Team1A>	Box B then?
12:59:16 <Team1A>	Let's do B
12:59:18 <Team1B>	ok
12:59:25 <Team1B>	done
12:59:28 <Team1A>	Done
12:59:42 <Team1A>	Ooh interesting
12:59:52 <Team1B>	strange
13:00:21 <Team1A>	Hmm
13:00:51 <Team1A>	I'm thinking don't transfer?
13:00:55 <Team1B>	why?
13:00:59 <Team1A>	And make it a bluff
13:01:18 <Team1A>	Or transfer then we at least get 45 rather than 40?
13:01:31 <Team1B>	if we transfer they will think there are more in box B
13:01:40 <Team1A>	We'll transfer then
13:01:44 <Team1B>	ok
13:01:48 <Team1A>	Done
13:01:55 <Team1B>	done
13:02:30 <Team1A>	Do we have one more after this?
13:02:34 <Team1B>	I think so
13:03:07 <Team1B>	actually I think I was wrong
13:03:11 <Team1B>	should be not transfer
13:03:12 <Team1B>	sorry

13:03:17 <Team1B> you were right
13:03:30 <Team1A> We don't know what they will choose so we might be okay
13:03:38 <Team1A> It's still a decent amount
13:03:39 <Team1B> hopefully
13:03:53 <Team1B> yeah not bad
13:04:01 <Team1B> not 5 tokens in the second round
13:04:20 <Team1A> Exactly
13:04:27 <Team1B> yeah sorry
13:04:32 <Team1A> And hopefully that'll be the round they pick to give us the money
13:04:35 <Team1A> No worries
13:05:25 <Team1B> how are you doing today
13:05:42 <Team1A> not bad thank you, yourself?
13:05:51 <Team1B> not too bad thx
13:06:53 <Team1B> what do you think
13:06:53 <Team1A> What are we thinking?
13:07:10 <Team1B> there might very few in A
13:07:22 <Team1B> or a lot in A
13:07:23 <Team1B> haha
13:07:30 <Team1A> Haha I know that's the dilemma
13:07:52 <Team1A> I'm thinking A but I'm not 100% confident
13:08:03 <Team1B> let’s do A then
13:08:06 <Team1A> Oh it says it's been decline
13:08:09 <Team1A> *declined
13:08:10 <Team1B> we have enough tokens
13:08:18 <Team1A> Okay so A?
13:08:26 <Team1B> yeah let’s do it
13:08:31 <Team1A> Done
13:08:35 <Team1B> Done
13:08:55 <Team1B> OH they won

Team 2:

Table 111: Scenarios faced by team 2

Trial	Role	Scenario	P1 decision	P2 decision
0	P1	BS30	Transfer	DT
1	P2	SB35	Transfer	DT
2	P1	SB20	No transfer	DF
3	P2	BS20	Transfer	DT
4	P1	BS5	No transfer	DF
5	P2	SB10	No transfer	DT

12:42:02 <Team2B> hi
12:42:25 <Team2A> how many tokens are you guys transferring
12:42:35 <Team2B> 30
12:42:39 <Team2A> ok
12:47:02 <Team2B> are we going to select the box with the highest payment?
12:47:48 <Team2A> yeap
12:48:00 <Team2B> perfect
12:48:42 <Team2B> so it is B
12:48:43 <Team2A> box B right
12:48:45 <Team2A> yeap
12:51:08 <Team2A> are we transferring?
12:51:15 <Team2B> I would say no
12:51:19 <Team2A> alright then
12:57:36 <Team2A> I think we should pick box b
12:57:51 <Team2B> I think it too

12:57:55 <Team2A> okay
12:59:24 <Team2B> either was A80 B40 and so now it's 60/60 or it was A20 B80 and now 20/100, right?
12:59:38 <Team2A> yeap
12:59:46 <Team2B> good
13:00:15 <Team2A> to transfer or not to
13:00:18 <Team2A> ?
13:00:29 <Team2A> I think we should transfer
13:00:29 <Team2B> this is tricky
13:00:45 <Team2B> any idea?
13:01:23 <Team2B> I'd say no
13:01:30 <Team2A> okay I'll put no
13:01:39 <Team2B> no it is
13:07:00 <Team2A> which box are you picking
13:07:15 <Team2B> I don't know
13:07:24 <Team2A> pick B I think
13:07:31 <Team2B> ok I'll put b
13:08:48 <Team2B> nice
13:09:13 <Team2A> <y>

Team 3:

Table 112: Scenarios faced by team 3

Trial	Role	Scenario	P1 decision	P2 decision
0	P1	BS30	No transfer	DT
1	P2	SB35	No transfer	DF
2	P1	SB20	Transfer	DT
3	P2	BS20	No transfer	DF
4	P1	BS5	Transfer	DF
5	P2	SB10	No transfer	DF

12:42:36 <Team3B> hey, what do you want to do?
12:42:47 <Team3A> don't transfer?
12:42:53 <Team3B> sure
12:42:58 <Team3A> cool
12:43:02 <Team3B> do it now?
12:43:06 <Team3A> yup
12:43:18 <Team3B> okay :)
12:46:01 <Team3B> yay!
12:46:07 <Team3A> yay
12:47:49 <Team3A> this is a long wait
12:47:59 <Team3B> I know!
12:48:20 <Team3B> don't really know what to do about choosing, it's basically just a guess
12:48:34 <Team3A> hmm
12:48:44 <Team3B> so they haven't transferred
12:48:52 <Team3B> what's your fav letter a or b? lol
12:49:01 <Team3A> ermmm
12:49:09 <Team3A> I would say A?
12:49:11 <Team3B> maybe A
12:49:15 <Team3A> haha same
12:49:20 <Team3B> I think the same let's go for it
12:49:28 <Team3A> hell yeah
12:49:44 <Team3B> sorry if it's wrong haha
12:50:19 <Team3A> if its wrong we will be left with only 5 tokens lol
<<subject suggests they may earn 5 tokens from picking A even though they know no transfer has been made; may not fully understand the game>>

12:50:34 <Team3A>	ooo
12:50:37 <Team3B>	you win some you lose some i guess
12:50:43 <Team3A>	I see
12:50:48 <Team3B>	ooo
12:51:12 <Team3B>	there was no outcome right?
12:51:29 <Team3A>	nope... its either 40 or 80 tokens
12:51:39 <Team3B>	want to transfer?
12:51:43 <Team3B>	or nah
12:51:48 <Team3A>	okay
12:51:53 <Team3A>	we transfer
12:51:58 <Team3B>	okay let's try it
12:52:40 <Team3A>	so the aim is to convince them that box b has more tokens…
12:52:48 <Team3A>	I mean box a haha
12:53:05 <Team3B>	ahhh I see
12:53:10 <Team3B>	smart move if it works
12:54:04 <Team3A>	let’s just hope so
12:54:10 <Team3B>	I hope you're lucky haha
12:55:09 <Team3B>	damn
12:55:15 <Team3A>	ah damn
12:55:24 <Team3B>	20 is better than nothing
12:55:31 <Team3A>	ikr
12:57:45 <Team3B>	what you thinking?
12:57:50 <Team3A>	ah
12:57:57 <Team3A>	don’t really know
12:58:01 <Team3A>	B this time?
12:58:11 <Team3B>	me either, I feel like if they declined it then they want more tokens
12:58:16 <Team3A>	yeah
12:58:22 <Team3B>	but they could be doing your trick
12:58:33 <Team3A>	its basically luck
12:58:40 <Team3A>	what do u think?
12:58:41 <Team3B>	I know!
12:58:47 <Team3B>	box a?
12:58:52 <Team3A>	cool
12:58:54 <Team3B>	sure?
12:59:01 <Team3B>	this is too much pressure haha
12:59:04 <Team3A>	hahah
12:59:08 <Team3A>	its fine this time
12:59:11 <Team3A>	40 or 80
12:59:21 <Team3B>	okay okay
12:59:25 <Team3B>	so A?
12:59:26 <Team3A>	A yeah
12:59:30 <Team3A>	click it
12:59:41 <Team3A>	haha yay
12:59:43 <Team3B>	yaaaaay!
12:59:52 <Team3B>	it's because I’m wearing my lucky necklace you see
12:59:56 <Team3A>	u rock haha
13:00:10 <Team3B>	5 tokens is good
13:00:17 <Team3B>	I think we should transfer
13:00:21 <Team3A>	cool
13:00:21 <Team3B>	to do the trick thing
13:00:26 <Team3B>	you sure?
13:00:46 <Team3A>	yeah...it’s only 5
13:00:57 <Team3B>	nice
13:02:22 <Team3B>	hopefully our earnings are based on a good one
13:02:34 <Team3A>	it’s a random round?
13:03:00 <Team3B>	I mean I hope the picked random one is a good one
13:03:07 <Team3B>	sorry ahaha
13:03:11 <Team3A>	hopefully not the one we got 20 tokens
13:03:20 <Team3B>	hopefully not no!
13:03:36 <Team3A>	haha… let’s not jinx it

13:03:46 <Team3B> you're right!
13:04:13 <Team3B> damn!
13:04:15 <Team3A> ahhhh
13:04:24 <Team3B> sorry that was my bad
13:04:28 <Team3A> its fine
13:04:33 <Team3B> you pick this one??
13:04:33 <Team3A> 45 is good enough
13:04:38 <Team3B> true
13:06:52 <Team3A> which one?
13:07:00 <Team3B> I don't know
13:07:01 <Team3A> A?
13:07:11 <Team3B> yeah let's stick to tradition
13:07:20 <Team3A> okay okay
13:07:22 <Team3B> A it is
13:07:39 <Team3A> can't really tell if they wanna lure us or not
13:08:00 <Team3B> depends how evil they are
13:08:14 <Team3A> yeah so let's pass it to fate
13:08:22 <Team3B> good idea
13:08:48 <Team3A> haiz
13:08:52 <Team3B> damn fate is not very nice
13:09:08 <Team3B> good round!
13:09:14 <Team3A> yeah
13:09:27 <Team3A> at least we got earnings
13:09:39 <Team3B> exactly
13:09:45 <Team3B> I feel like we were a good team
13:10:02 <Team3A> we were!

Team 4:

Table 113: Scenarios faced by team 4

Trial	Role	Scenario	P1 decision	P2 decision
0	P2	BS30	Transfer	DT
1	P1	SB35	No transfer	DF
2	P2	SB20	Transfer	DT
3	P1	BS20	Transfer	DT
4	P2	BS5	No transfer	DF
5	P1	SB10	No transfer	DF

12:41:57 <Team4B> hi
12:42:10 <Team4B> how do you want to go about it?
12:42:14 <Team4A> hello, I assume we're choosing this time
12:42:23 <Team4A> I don't mind
12:42:34 <Team4A> I suppose we wait to see what the other people have said
12:42:53 <Team4B> it's a chat between just the 2 of us
12:43:06 <Team4B> if you are splitting then I will follow you
12:43:11 <Team4B> and if I split follow me
12:43:19 <Team4B> we have to have the same options selected
12:43:19 <Team4A> yeah I know
12:43:50 <Team4B> like if I transfer from a to b assume that b has better values and select b
12:44:08 <Team4A> so 30 tokens have been transferred
12:44:22 <Team4A> do we go B?
12:44:25 <Team4B> should we go for b?
12:44:34 <Team4B> yeah I think so
12:44:41 <Team4A> we go B then yeah?
12:44:47 <Team4B> yes let's go for it
12:44:49 <Team4B> all the best
12:44:56 <Team4A> have clicked box B
12:45:16 <Team4B> same here

12:45:25 <Team4A> perfect
12:46:06 <Team4A> 70!!!
12:46:18 <Team4B> that’s awesome
12:46:45 <Team4B> let’s select box b and not make a transfer
12:47:05 <Team4A> no transfer
12:47:06 <Team4B> because if we make a transfer and they opt for box b, we are left with only 5 tokens in box a
12:47:10 <Team4A> yeah exactly
12:47:20 <Team4B> so am selecting no transfer
12:47:27 <Team4A> same, have clicked no transfer
12:48:35 <Team4A> now we have to wait
12:48:42 <Team4A> let’s hope they click A aha
12:48:48 <Team4B> yes, hoping they choose a
12:50:36 <Team4B> yes!
12:50:43 <Team4A> that’s amazing!
12:50:44 <Team4B> 80!
12:51:13 <Team4A> the wait is so long
12:51:19 <Team4B> lets be careful this time, they might try to trick us this time
12:51:25 <Team4A> yeah okay
12:51:28 <Team4B> yes that is the irritating part
12:52:50 <Team4A> although the opposition are randomly assigned
12:52:58 <Team4A> so we probably won’t have the same people again
12:53:05 <Team4B> oh yes true
12:53:10 <Team4A> B?
12:53:19 <Team4A> if it started with 40 then it now has 60
12:53:27 <Team4A> or if it started with 80 then it now has 100
12:53:32 <Team4B> yes true that
12:53:40 <Team4B> anyways we would have a decent total
12:53:49 <Team4B> lets go with b
12:53:52 <Team4A> b
12:54:01 <Team4A> clicked B
12:54:07 <Team4B> same here!
12:54:11 <Team4B> good luck!
12:54:21 <Team4A> thanks aha
12:55:07 <Team4B> woohoo
12:55:08 <Team4A> wow!!
12:55:48 <Team4A> transfer?
12:55:53 <Team4B> if we make a transfer both end getting 60
12:55:56 <Team4B> so yeah let’s do it
12:56:06 <Team4A> clicked transfer
12:56:16 <Team4B> yep same here
12:59:45 <Team4A> just like we expected
12:59:55 <Team4B> yes, they went with the transfer
13:00:18 <Team4B> next time we might take a risk and maximise our points
13:00:37 <Team4A> we could, but they randomly select one of the trials for our pay
13:00:40 <Team4A> so if we risk it
13:00:42 <Team4A> and lose
13:00:50 <Team4A> and they select this trial
13:00:55 <Team4A> then we don’t get much money
13:01:02 <Team4A> I suppose it all depends on what choices we have though
13:01:15 <Team4B> yes that’s a valid point
13:01:23 <Team4B> let’s see how it progresses
13:01:38 <Team4A> yeah, cos some have been straightforward, it depends on the numbers
13:02:00 <Team4B> yes okay, let’s see the transfer first
13:02:41 <Team4B> a or b?
13:02:49 <Team4A> I don't know, feel like it could be a trick
13:02:56 <Team4B> same here
13:03:10 <Team4A> I feel like going a
13:03:29 <Team4B> the transfer has been declined it says

13:03:30 <Team4A> because I think they want us to think there is more in B so they didn't transfer
13:03:53 <Team4B> okay let's take a
13:04:00 <Team4A> a
13:04:15 <Team4B> awesome!
13:04:16 <Team4A> success!
13:04:50 <Team4A> what do we do?
13:05:14 <Team4B> let's just choose a, we at least win 40
13:05:23 <Team4B> and if we win 80 it's our good day
13:05:30 <Team4B> better than winning 30 anyways
13:05:32 <Team4A> yeah okay, so no transfer
13:05:33 <Team4A> true
13:05:36 <Team4B> yep done
13:05:47 <Team4A> same, and this is our last one I think
13:06:03 <Team4B> I think there's one more left isn't it?
13:06:14 <Team4A> I feel like this could be the 6th
13:06:16 <Team4A> but not sure aha
13:06:30 <Team4B> haha, we shall know in 2 mins
13:06:46 <Team4A> a very long 2 mins
13:07:06 <Team4B> yes, let's hope it's the last. no more waits
13:07:24 <Team4A> yeah, it seems ages, but then on the previous one we did spend 2 minutes deciding
13:07:53 <Team4B> yes that was tricky, for the others we were done in under a minute
13:08:48 <Team4B> our good day!
13:08:49 <Team4A> wow!!!
13:08:57 <Team4A> we never got less than half
13:09:04 <Team4B> yeah
13:09:07 <Team4B> congrats

Team 5:

Table 114: Scenarios faced by team 5

Trial	Role	Scenario	P1 decision	P2 decision
0	P2	BS30	Transfer	DT
1	P1	SB35	Transfer	DT
2	P2	SB20	No Transfer	DF
3	P1	BS20	Transfer	DT
4	P2	BS5	Transfer	DF
5	P1	SB10	No Transfer	DF

12:42:13 <Team5A> hello
12:42:17 <Team5B> hello
12:42:29 <Team5A> what are you assessing to do?
12:42:45 <Team5B> let's see the strategy
12:42:58 <Team5A> don't we need to pick the same?
12:43:03 <Team5B> what the other team has done
12:43:08 <Team5B> yes we need to
12:43:15 <Team5A> okay
12:43:26 <Team5A> so we just wait?
12:43:35 <Team5B> yes I guess
12:43:41 <Team5A> okay cool
12:44:08 <Team5A> what would you like to do
12:44:13 <Team5B> shall we take b
12:44:25 <Team5A> okay
12:44:40 <Team5A> have you selected it?
12:44:42 <Team5A> selected
12:44:46 <Team5B> so box b it is
12:44:49 <Team5B> yes

12:44:50 <Team5A>	yes
12:44:57 <Team5A>	done
12:45:09 <Team5B>	done as well
12:46:18 <Team5B>	nice choice
12:46:22 <Team5A>	did well
12:46:25 <Team5B>	haha
12:46:46 <Team5A>	I guess we shouldn't transfer?
12:47:08 <Team5B>	but what if they choose b
12:47:15 <Team5A>	how can you make them not choose B
12:47:32 <Team5A>	you decide
12:47:39 <Team5A>	I'll match you
12:47:41 <Team5B>	ok let's do it
12:47:47 <Team5B>	let's transfer
12:47:48 <Team5A>	so transfer?
12:47:49 <Team5A>	okay
12:47:53 <Team5B>	yes transfer
12:47:58 <Team5A>	ok done
12:48:08 <Team5B>	done as well
12:49:02 <Team5A>	I think 5 may come our way
12:49:19 <Team5B>	yes I have the same feeling
12:49:30 <Team5A>	fingers crossed
12:49:33 <Team5B>	yes
12:50:35 <Team5A>	oh dear
12:50:39 <Team5B>	as expected
12:50:44 <Team5A>	we won't do that again
12:50:49 <Team5B>	yes
12:53:24 <Team5A>	what do you think
12:53:27 <Team5B>	shall we take box a
12:53:35 <Team5A>	I was thinking so
12:53:46 <Team5A>	A?
12:53:48 <Team5B>	so box a then
12:53:51 <Team5B>	yes a
12:53:52 <Team5A>	yeah
12:54:06 <Team5B>	done box a
12:54:10 <Team5A>	same
12:55:14 <Team5B>	what the hell
12:55:18 <Team5A>	haha
12:55:22 <Team5A>	double bluff
12:55:28 <Team5B>	lets change a bit now onwards
12:55:42 <Team5A>	I say don't transfer
12:56:02 <Team5A>	or that's risky
12:56:06 <Team5B>	but if we transfer we will get minimum 60 instead of 40
12:56:17 <Team5A>	yeah but could risk
12:56:18 <Team5A>	okay
12:56:24 <Team5A>	we will transfer then
12:56:28 <Team5B>	so I suggest it makes sense to transfer
12:56:31 <Team5A>	okay
12:56:35 <Team5B>	yes let's transfer
12:56:39 <Team5A>	done
12:56:48 <Team5B>	done as well
13:02:24 <Team5A>	I think A might be larger
13:02:29 <Team5A>	but it's a guess
13:02:33 <Team5B>	yes so do I
13:02:39 <Team5A>	okay shall we choose a
13:02:41 <Team5B>	let's take a then
13:02:44 <Team5A>	I don't know though it's a guess
13:02:48 <Team5B>	yes let's choose a
13:02:53 <Team5A>	okay
13:02:54 <Team5A>	done
13:03:06 <Team5B>	yes let's go with it

13:03:11 <Team5A> who knows
13:03:14 <Team5B> done as well
13:03:21 <Team5A> nice
13:04:13 <Team5A> yay result
13:04:19 <Team5B> haha nice
13:04:50 <Team5A> I think no transfer
13:04:55 <Team5B> I would say let's not transfer
13:04:59 <Team5A> then they will have to guess
13:04:59 <Team5B> yes same
13:05:02 <Team5A> so its 50 50
13:05:05 <Team5A> okay cool
13:05:15 <Team5B> yes let's go with no transfer
13:05:23 <Team5A> transfer has not been made
13:05:24 <Team5A> done
13:05:38 <Team5B> done as well
13:06:52 <Team5A> a lot of waiting in this game
13:07:13 <Team5A> anticipation
13:07:14 <Team5B> yes needs a lot of patience
13:07:19 <Team5A> indeed
13:07:20 <Team5B> haha true
13:07:46 <Team5A> I hear a lot of typing, maybe people are more tactical than us haha
13:07:56 <Team5B> haha let's hope not
13:08:00 <Team5A> let's hope not
13:08:50 <Team5A> nice!
13:08:55 <Team5B> nice

Team 6:

Table 115: Scenarios faced by team 6

Trial	Role	Scenario	P1 decision	P2 decision
0	P2	BS30	No Transfer	DT
1	P1	SB35	Transfer	DT
2	P2	SB20	No Transfer	DF
3	P1	BS20	No transfer	DF
4	P2	BS5	Transfer	DF
5	P1	SB10	No transfer	DT

12:42:17 <Team6B> Splitters?
12:42:35 <Team6B> What are we deciding on?
12:43:23 <Team6B> ?!
12:45:00 <Team6A> I forgot… do Choosers all have to choose the same box too?
12:45:24 <Team6B> Yes
12:45:32 <Team6B> Otherwise we get a penalty
12:45:37 <Team6A> ok Choosers what are we choosing??
12:45:43 <Team6A> B?
12:45:56 <Team6B> I picked B
12:46:48 <Team6A> Splitters,
12:47:27 <Team6A> transfer or not?
12:47:34 <Team6B> Transfer
12:50:15 <Team6A> I picked B
12:50:52 <Team6B> can we decide not to transfer
12:50:57 <Team6A> yes
12:51:30 <Team6B> and the Splitter can suggest the box with 40 coins to the other members
12:54:16 <Team6B> A?
12:54:32 <Team6A> I picked b
12:56:05 <Team6B> no transfer
12:56:47 <Team6A> who can actually see this chat? Both teams?
12:57:33 <Team6B> don't think so

12:58:09 <Team6B> but how do you coordinate then?
12:58:19 <Team6A> so did you just act as Splitter?
12:58:25 <Team6B> yes
12:58:36 <Team6A> ah makes sense now
12:59:09 <Team6B> how?
12:59:30 <Team6A> I thought the A/B part was Splitter/Chooser but it's not
12:59:50 <Team6B> Oh
12:59:54 <Team6B> alright
12:59:58 <Team6B> that makes sense
13:01:54 <Team6A> is there any real strategy or is it just a lot of luck / guessing??
13:02:27 <Team6B> luck and guessing. and figuring out the chat
13:02:35 <Team6B> A?
13:02:42 <Team6A> can't see their chat though?
13:02:56 <Team6B> exactly
13:02:57 <Team6A> ok
13:03:45 <Team6A> fingers crossed ;)
13:04:13 <Team6A> yes then
13:04:15 <Team6B> Finally!
13:05:08 <Team6A> so, last time they transferred a tiny amount to look like they were doing us a favour... hoping we would pick the box they transferred to
13:05:12 <Team6B> Not make transfer? If they choose B, we'll end up getting 30
13:05:17 <Team6A> exactly
13:06:26 <Team6A> by not transferring hopefully they'll think A is better
13:06:46 <Team6B> I hope so
13:07:09 <Team6B> does A always have 40?
13:07:20 <Team6B> excluding transfer
13:07:41 <Team6A> I think the instructions said it's randomised, there's 40 + 80 between either of them
13:08:18 <Team6B> makes sense
13:08:47 <Team6A> nah they didn't fall for it

Session 2
Team 7

Table 116: Scenarios faced by team 7

Trial	Role	Scenario	P1 decision	P2 decision
0	P1	BS30	Penalty (transfer)	DF
1	P2	SB35	Transfer	DT
2	P1	SB20	No transfer	DT
3	P2	BS20	No transfer	DT
4	P1	BS5	No transfer	DF
5	P2	SB10	No transfer	DT

13:56:26 <Team7B> hey
13:56:31 <Team7A> hi
13:56:45 <Team7B> lets play x
13:56:48 <Team7B> ?
13:56:53 <Team7A> yep
13:57:05 <Team7A> not really sure
13:57:26 <Team7A> its whether we want to risk it and go for 80 or play it safe
13:57:40 <Team7B> what do u want
13:57:49 <Team7A> I say go for it
13:57:55 <Team7B> risk
13:57:56 <Team7B> ?
13:57:57 <Team7A> and do not make transfer
13:58:08 <Team7B> ok
13:58:14 <Team7A> done

13:58:56 <Team7B> box A?
13:59:15 <Team7A> we are waiting for them to choose I think
13:59:31 <Team7A> did you choose, do not make transfer?
13:59:32 <Team7B> yeah
13:59:37 <Team7B> yeah
13:59:49 <Team7B> I did transfer
14:00:09 <Team7A> I didn't, we didn't make the same choice so we get 0 now
14:00:24 <Team7B> oh fuck
14:00:27 <Team7B> I am sorry
14:00:41 <Team7A> its ok
14:00:54 <Team7A> just make sure to make the same one for the rest of them
14:00:57 <Team7B> yup
14:03:09 <Team7B> which box
14:03:12 <Team7B> ?
14:03:15 <Team7A> I say definitely box b
14:03:19 <Team7B> ok
14:03:21 <Team7B> B
14:03:26 <Team7A> then we are guaranteed at least 75
14:03:38 <Team7B> done
14:03:40 <Team7A> or 115
14:04:08 <Team7A> is your current choice box b?
14:04:34 <Team7B> yes
14:04:40 <Team7A> ok, good :)
14:04:51 <Team7B> sorry for the last one
14:04:58 <Team7A> no worries
14:05:15 <Team7A> ok good, we won a lot that time
14:05:17 <Team7B> perfect
14:05:40 <Team7A> do not make transfer
14:05:44 <Team7B> ok
14:06:02 <Team7B> current choice: no transfer
14:06:09 <Team7A> good
14:06:16 <Team7A> leave it at that :)
14:08:18 <Team7A> we will get 40 or 80 this round so not too bad, equally likely
14:08:25 <Team7B> yup
14:09:48 <Team7A> not great but not awful
14:09:50 <Team7B> anyways
14:09:58 <Team7B> ha ha
14:10:54 <Team7B> this is so cool feels like u are sitting 1990's chat room!
14:11:02 <Team7A> haha yep
14:12:12 <Team7A> just a guess really
14:12:34 <Team7B> hmm...B?
14:12:50 <Team7A> yeah I'ld say so
14:12:56 <Team7A> I've chosen box b
14:12:58 <Team7B> ok B then
14:14:17 <Team7A> unlucky
14:14:28 <Team7B> yeah
14:14:50 <Team7A> hmmm idk
14:15:16 <Team7B> lol its just 5
14:15:16 <Team7A> depends how smart the others are
14:15:30 <Team7A> no but it effects their decision
14:15:43 <Team7B> yup
14:15:46 <Team7A> I'ld say do not make transfer I think
14:15:55 <Team7B> ok
14:16:08 <Team7B> let's not make the transfer
14:16:11 <Team7A> ok
14:16:13 <Team7A> done
14:16:19 <Team7A> no transfer
14:18:56 <Team7A> this is not going well
14:19:01 <Team7B> yeah
14:19:04 <Team7A> we are unlucky

14:19:22 <Team7B> no no... relax
14:19:44 <Team7A> hopefully the 115 one will get selected
14:19:50 <Team7B> ha ha
14:19:56 <Team7B> definitely
14:21:41 <Team7B> which one?
14:21:42 <Team7A> I really don’t know
14:22:10 <Team7B> Hmm...well if I say with probability
14:22:10 <Team7A> b again? idk
14:22:14 <Team7B> b
14:22:18 <Team7B> ha ha
14:22:19 <Team7A> ok
14:22:23 <Team7A> I’ve chosen b
14:22:36 <Team7B> but don't kill me I have done enough damage!
14:22:48 <Team7A> haha dont worry
14:22:54 <Team7A> I should have made it clearer
14:23:21 <Team7A> woo haha
14:23:32 <Team7B> cheers
14:23:39 <Team7A> no worries, thank you

Team 8

Table 117: Scenarios faced by team 8

Trial	Role	Scenario	P1 decision	P2 decision
0	P1	BS30	Transfer	DF
1	P2	SB35	No transfer	DF
2	P1	SB20	Transfer	DT
3	P2	BS20	Transfer	DT
4	P1	BS5	Transfer	DT
5	P2	SB10	Transfer	DT

13:56:34 <Team8A> Hi
13:57:01 <Team8B> hi. decide to transfer?
13:57:22 <Team8A> Yes.
13:57:33 <Team8B> cool
13:57:53 <Team8A> The Chooser might think A still has more and that is why we transferred
13:57:58 <Team8A> So might pick A.
13:58:05 <Team8A> That will give us more points
13:58:14 <Team8B> yeah, sounds good
13:58:20 <Team8A> So make a transfer
14:00:44 <Team8A> It worked!
14:00:55 <Team8B> good job!
14:01:14 <Team8A> We are the Chooser now.
14:03:26 <Team8B> I'm thinking box a?
14:03:33 <Team8A> Yes.
14:04:04 <Team8B> cool
14:04:42 <Team8A> They could be tricking us. If did not transfer, they might want us to think B already has more and so we'll choose that. But let's go with A.
14:04:57 <Team8B> cool
14:05:10 <Team8A> Damn.
14:05:13 <Team8B> oh, well
14:05:46 <Team8B> do you think we should trick them this time?
14:05:53 <Team8B> decline a transfer?
14:05:53 <Team8A> But how?
14:06:21 <Team8A> Then that will be using their trick. They might pick B
14:06:21 <Team8B> they might think A has more. like we did
14:06:28 <Team8B> fair enough
14:06:34 <Team8B> yes to transfer then?

14:06:57 <Team8A> I guess.
14:07:06 <Team8A> Give a final word?
14:07:07 <Team8A> Quick
14:07:10 <Team8B> alright
14:07:12 <Team8B> make it
14:07:32 <Team8A> This game is tricky. I have a bad feeling about this round
14:08:06 <Team8B> that's alright. we'll make up for it in another one
14:09:47 <Team8B> oh damnit
14:09:49 <Team8A> I'm sorry
14:09:58 <Team8B> no worries
14:10:05 <Team8A> Whatever you pick now.
14:10:43 <Team8B> oh, not the best idea. but sure!
14:12:17 <Team8B> I'm thinking b?
14:12:21 <Team8A> cool
14:12:41 <Team8B> could they be tricking us by making a transfer?
14:13:03 <Team8A> May or may not. No way to say for sure
14:13:35 <Team8B> transferring 20 from 80 tokens or 40 works fine for us either way
14:13:59 <Team8B> either equal or more
14:14:03 <Team8B> go with b
14:14:56 <Team8B> transfer?
14:15:02 <Team8A> Yeah. Same opinion
14:15:10 <Team8B> cool, let's do it
14:18:59 <Team8A> Not bad at all!
14:19:16 <Team8B> yeah
14:19:24 <Team8B> this is the last one, isn't it?
14:19:29 <Team8A> yeah
14:19:55 <Team8B> well, good luck then
14:20:10 <Team8A> Good luck to you too
14:21:33 <Team8B> what do you think?
14:22:21 <Team8B> I think b. it'll be either 50 or 90 tokens
14:22:24 <Team8A> Umm, maybe b
14:22:36 <Team8A> B then.
14:22:41 <Team8B> cool
14:23:24 <Team8B> oh wow
14:23:27 <Team8B> interesting
14:23:38 <Team8A> got lucky!

Team 9

Note: Team 9 did not manage to communicate at all; they did not seem to understand the task and even after the experimenter coming to them twice during the experiment they remained confused throughout.

Table 118: Scenarios faced by team 9

Trial	Role	Scenario	P1 decision	P2 decision
0	P1	BS30	Penalty (transfer)	DT
1	P2	SB35	No transfer	DT
2	P1	SB20	Penalty (transfer)	DT
3	P2	BS20	Transfer	DT
4	P1	BS5	Transfer	DT
5	P2	SB10	No transfer	DF

13:56:52 <Team9B> hi what should we decide?
13:57:09 <Team9B> I'll choose a
13:57:28 <Team9B> for every trial
13:57:44 <Team9B> is that ok?
13:58:17 <Team9B> hi
13:59:20 <Team9A> b
13:59:32 <Team9B> we have to make the same choice
13:59:42 <Team9B> if you choose b I'll choose b
14:00:01 <Team9B> so we'll choose b?
14:00:05 <Team9B> is that ok?
14:00:21 <Team9B> please reply
14:01:01 <Team9B> b?
14:01:08 <Team9A> ok
14:01:33 <Team9A> so I'll choose b?
14:01:41 <Team9B> yes
14:05:15 <Team9B> b again?
14:05:47 <Team9B> choose b again?
14:05:48 <Team9A> yeah b
14:09:45 <Team9A> what I'm so confused
14:09:55 <Team9B> you have to choose b
14:10:00 <Team9A> I did
14:10:40 <Team9B> I did previously and its worked
14:11:03 <Team9B> I'll choose b again?
14:11:37 <Team9A> ok I'll choose b
14:14:40 <Team9A> ok what should we do?
14:14:55 <Team9A> choose no?
14:15:01 <Team9B> choose box a
14:15:27 <Team9B> click on the grey button since you are the Chooser
14:15:54 <Team9B> this is also confusing for me
14:16:02 <Team9A> should I choose to make the transfer or not
14:16:07 <Team9B> but I think we should choose box a
14:16:10 <Team9B> I make transfer
14:16:28 <Team9B> and I'll choose a
14:16:37 <Team9A> ok yes
14:19:40 <Team9B> we have to make the same choice
14:19:47 <Team9B> box a this time?
14:20:00 <Team9A> ok I'll choose a
14:20:04 <Team9B> ok
14:21:31 <Team9B> I just clicked a
14:21:49 <Team9A> how?
14:21:53 <Team9A> oh
14:21:59 <Team9A> ok I get it
14:22:05 <Team9A> I chose a
14:22:10 <Team9B> there is grey button

Team 10

Table 119: Scenarios faced by team 10

Trial	Role	Scenario	P1 decision	P2 decision
0	P2	BS30	Transfer	DT
1	P1	SB35	No transfer	DF
2	P2	SB20	No transfer	DT
3	P1	BS20	Transfer	DT
4	P2	BS5	transfer	DT
5	P1	SB10	Penalty (transfer)	DT

13:57:34 <Team10B> are you still waiting?
13:57:38 <Team10A> so one has 40 the other 80 and we wait to see if they transfer right?

13:57:39 <Team10A> yeah
13:57:57 <Team10B> so we wait till the time runs out?
13:58:02 <Team10A> yh
13:58:04 <Team10B> ok
13:58:15 <Team10A> and then decide to pick a box
13:58:24 <Team10B> ok yeah got it :)
13:58:51 <Team10A> we either have 10 or 110
13:58:57 <Team10B> a transfer of 30 tokens has made from box A to box B
13:59:01 <Team10A> or 50 or 70
13:59:05 <Team10A> yh
13:59:10 <Team10B> Which one are you choosing
13:59:12 <Team10A> there are 4 situations
13:59:26 <Team10B> ok
13:59:34 <Team10A> let s pick B
13:59:42 <Team10B> Yup agreed, I'll go with B too
13:59:51 <Team10A> ok
13:59:54 <Team10A> I put box B
14:00:05 <Team10B> All the possibilities turn to B being the better choice
14:00:10 <Team10A> yh
14:00:10 <Team10B> I have put B as well
14:00:43 <Team10A> sweet
14:00:46 <Team10A> 70
14:00:49 <Team10B> nice
14:00:53 <Team10B> good job at guessing
14:00:59 <Team10A> ahaha same
14:01:09 <Team10B> are you transferring?
14:01:17 <Team10A> I'd say no
14:01:21 <Team10B> Okay me too
14:01:24 <Team10A> hbu?
14:01:25 <Team10B> Let's not transfer
14:01:30 <Team10A> ok not transfer
14:01:32 <Team10B> I'll go w your choice
14:01:46 <Team10B> Chosen no transfer
14:01:49 <Team10A> it really depends on how risk averse the other team is
14:02:00 <Team10A> ok chose no transfer
14:02:30 <Team10B> I don't want a probability of getting 5 lol
14:02:47 <Team10A> yh exactly
14:02:49 <Team10A> exactly
14:02:57 <Team10A> so no transfer remains
14:03:11 <Team10B> yup
14:04:25 <Team10A> Team 70
14:04:27 <Team10A> fantastic4
14:04:30 <Team10A> lol
14:04:33 <Team10B> hahahaahahaha
14:05:10 <Team10A> 80
14:05:11 <Team10B> YAYY GET IN
14:05:17 <Team10A> CASH IN
14:07:47 <Team10B> okay so a transfer got declined
14:07:57 <Team10A> so it is either 40/80 in each box
14:08:00 <Team10A> right?
14:08:01 <Team10B> yeah
14:08:18 <Team10A> y would they not transfer
14:08:32 <Team10B> I feel like the possibility a transfer was declined is maybe if they did transfer box A would have the 40 tokens
14:08:51 <Team10B> I don't know, we just have to gamble on this one I think
14:08:58 <Team10A> so which one you say we should pick?
14:09:07 <Team10B> which one do you think
14:09:08 <Team10B> b?
14:09:15 <Team10B> let's try b
14:09:20 <Team10A> hmm don't know might be a as well

14:09:25 <Team10A>	but let's go b if you say so
14:09:28 <Team10A>	b?
14:09:32 <Team10B>	yup
14:09:40 <Team10B>	YAY
14:09:43 <Team10A>	nice
14:09:50 <Team10A>	we're halfway through
14:09:51 <Team10B>	PHEW was close
14:09:58 <Team10B>	I know
14:10:07 <Team10A>	yh really close
14:10:15 <Team10B>	should we transfer?
14:10:33 <Team10A>	if we transfer we win for sure 60
14:10:36 <Team10A>	if we don't
14:10:44 <Team10A>	it's going to either be 80 or 40
14:10:47 <Team10B>	Yup, you make the decision on this
14:10:51 <Team10B>	I'll go with it
14:10:55 <Team10A>	safe bet or risk it out?
14:11:12 <Team10B>	which one would you go for
14:11:26 <Team10A>	I'd say no transfer
14:11:35 <Team10B>	okay I'm going with you
14:11:42 <Team10A>	hope I'm right
14:11:46 <Team10A>	sorry
14:11:48 <Team10A>	make transfer
14:11:54 <Team10A>	put make transfer
14:11:55 <Team10A>	!!!
14:12:03 <Team10B>	okay make transfer
14:12:13 <Team10A>	phew close call
14:12:15 <Team10B>	made so this one we can relax
14:12:27 <Team10A>	yh
14:13:05 <Team10A>	they are quite risk averse I'd say
14:13:15 <Team10A>	I think they might pick box A
14:13:20 <Team10B>	I thought it was different teams each round?
14:13:27 <Team10A>	in which case we lost potentially 20 tokens
14:13:34 <Team10A>	aaah yh
14:13:36 <Team10A>	fuck
14:13:38 <Team10A>	yh ur right
14:13:40 <Team10A>	ahaha
14:13:59 <Team10B>	yeah, but let's just hope our chosen round is our highest round lol
14:14:05 <Team10A>	I was trying to spot a behaviour
14:14:10 <Team10A>	yh same
14:14:27 <Team10B>	they chose b
14:14:35 <Team10A>	yh they did
14:15:01 <Team10A>	this is 5
14:15:06 <Team10A>	right?
14:15:07 <Team10B>	5?
14:15:13 <Team10B>	oh yeah I think so
14:15:14 <Team10A>	like fifth round
14:15:26 <Team10B>	yup should be
14:15:46 <Team10A>	so we have 70 80 80 60?
14:16:03 <Team10B>	yup that's what we have
14:16:10 <Team10A>	most prob 10 tokens=£!
14:16:15 <Team10A>	£1*
14:16:28 <Team10A>	0-120 tokens and they pay 0-12 gbp
14:16:34 <Team10B>	yeah seems right
14:16:47 <Team10B>	oooooh 5 tokens
14:17:07 <Team10A>	if we pick A
14:17:13 <Team10A>	we either have 75 or 35
14:17:17 <Team10B>	yeah
14:17:22 <Team10A>	if we pick B we either have 85 or 45
14:17:26 <Team10B>	yup
14:17:31 <Team10A>	pick B then?

14:17:45 <Team10B>	b?
14:17:56 <Team10A>	yh I'd say B
14:18:10 <Team10A>	both options are higher in B
14:18:16 <Team10A>	with 50/50 chances
14:18:26 <Team10B>	okay :)
14:18:31 <Team10A>	put B
14:18:51 <Team10A>	sorry
14:18:57 <Team10B>	No no its fine
14:19:05 <Team10A>	realised last minute it could've been a trap
14:19:05 <Team10B>	I think they were trying to trick us
14:19:08 <Team10B>	yeah
14:19:10 <Team10B>	no that’s fine
14:19:21 <Team10A>	shall we do the same?
14:19:27 <Team10B>	I say we don’t make the transfer
14:19:31 <Team10A>	ok
14:19:40 <Team10A>	I'll stick with your decision
14:19:50 <Team10B>	what do you think?
14:19:55 <Team10A>	but I'm thinking
14:20:02 <Team10B>	okay
14:20:06 <Team10B>	we have time don’t worry
14:20:06 <Team10A>	we can do the same scam
14:20:25 <Team10A>	like transfer 10 how they transferred 5
14:20:33 <Team10B>	but what if they never think of it being a trap and go for box b?
14:20:42 <Team10B>	then we're stuck with a
14:20:43 <Team10B>	so?
14:20:50 <Team10A>	yeah I know
14:20:59 <Team10B>	just say a decision
14:21:04 <Team10A>	I'll follow you
14:21:05 <Team10A>	say
14:21:09 <Team10B>	no transfer
14:21:22 <Team10B>	did you pick the same?
14:21:28 <Team10A>	didn't have the time to pick
14:21:34 <Team10A>	the computer will randomly pick
14:21:39 <Team10A>	fuck
14:21:40 <Team10B>	okay
14:21:42 <Team10A>	sorry man
14:21:42 <Team10B>	no its fine
14:21:46 <Team10B>	I don’t mind
14:21:48 <Team10B>	:)
14:22:25 <Team10A>	so it transferred
14:22:29 <Team10B>	yeah
14:22:35 <Team10A>	the computer transferred the money
14:22:37 <Team10A>	money
14:22:42 <Team10B>	just hope that they think it’s a trap
14:22:44 <Team10A>	I was thinking doing the same tbh
14:22:52 <Team10B>	but I don’t think this round we would get any cash
14:22:53 <Team10A>	yh and pick A
14:25:15 <Team10A>	I thought they said that if one of their team members doesn't pick
14:25:25 <Team10A>	the computer will randomly pick
14:25:40 <Team10B>	no I think it meant like if we don’t pick to make a transfer
14:25:47 <Team10B>	the comp will pick
14:26:23 <Team10A>	yh whatever

Team 11

Table 120: Scenarios faced by team 11

Trial	Role	Scenario	P1 decision	P2 decision
0	P2	BS30	Transfer	DF

1	P1	SB35	Transfer	DT
2	P2	SB20	Transfer	DT
3	P1	BS20	Transfer	DT
4	P2	BS5	Transfer	DT
5	P1	SB10	No transfer	DF

13:56:27 <Team11A> hello
13:56:29 <Team11B> hi
13:57:07 <Team11A> what you clicking?
13:57:10 <Team11B> I'm thinking it's a good idea to play fair since there are only 6 trials
13:57:16 <Team11A> okay :)
13:57:34 <Team11A> Promise fair and I'll click on whatever you tell me to
13:57:50 <Team11B> ok promise
<<Participants did not understand that they chat with a teammate; they initially think their chat is with the opponent>>
13:57:56 <Team11B> Box A?
13:57:56 <Team11A> A or B
13:58:00 <Team11A> A, sure
13:58:05 <Team11B> great
13:58:59 <Team11A> How many are in each? 50/50?
<<Participant did not pay attention at the start of the experiment since it was made clear that the initial values are always 40/80 or 80/40; It thus does not make sense to ask whether the boxes started as 50/50>>
13:59:05 <Team11A> I clicked A
13:59:12 <Team11B> 30 tokens have been transferred to B
13:59:26 <Team11A> What does that mean though? What is in A?
13:59:39 <Team11B> so there is 50 in A
13:59:47 <Team11B> and 80 in B
13:59:55 <Team11A> Okay, gotcha
13:59:58 <Team11B> but I'll go for A so we make the same choice
14:00:36 <Team11B> whooo
14:00:41 <Team11B> we made the same
14:00:46 <Team11A> yes!
14:01:27 <Team11B> ok box A = 40 tokens
14:01:33 <Team11B> Box B = 80 tokens
14:01:37 <Team11A> yes
14:01:41 <Team11A> what should I do?
14:01:43 <Team11B> transfer is 35 to box b
14:01:47 <Team11A> yes
14:01:50 <Team11B> it makes sense to choose box b
14:01:54 <Team11A> okay
14:01:59 <Team11B> I will make the transfer to B
14:02:01 <Team11A> and make transfer?
14:02:18 <Team11A> I have the options this time?
14:02:25 <Team11B> yes
14:02:26 <Team11A> I am making transfer to B
14:02:49 <Team11A> I made the transfer
14:02:56 <Team11B> I have already picked to transfer to B
14:02:57 <Team11A> to B
14:03:20 <Team11A> you are the Chooser now?
14:03:33 <Team11A> it says you are choosing between A and B
14:03:37 <Team11B> think so
14:03:44 <Team11B> no I'm not
14:03:49 <Team11B> I can't click anything
14:03:51 <Team11A> I'm not either though...
14:03:57 <Team11B> it's the other team
14:04:01 <Team11A> OH
14:04:08 <Team11B> we have to wait
14:04:27 <Team11B> I wish there had been a practice round
14:04:30 <Team11A> same

14:04:40 <Team11A> this is risky but I think I understand it now
14:04:47 <Team11A> hopefully they choose A lol
14:04:49 <Team11B> yeah it took me a min to understand it
14:05:11 <Team11A> DAMMIT
14:05:14 <Team11B> huh
14:05:15 <Team11A> aha
14:05:24 <Team11A> they won
14:05:29 <Team11B> how?
14:05:52 <Team11A> they got more of the tokens we just got 5
14:05:56 <Team11A> what does it say?
14:06:14 <Team11B> the other player is assessing a potential transfer
14:06:26 <Team11A> okay so it's the other team now
14:07:17 <Team11A> Oh wait.... are we on different teams?
14:07:35 <Team11B> yeah it changes teams each round
14:07:51 <Team11A> Okay, both choose B
14:07:55 <Team11B> yeah sure
14:08:15 <Team11A> Box B
14:08:22 <Team11B> done
14:08:48 <Team11A> This game is confusing me a bit now
14:08:55 <Team11B> yeah I don’t get it
14:09:17 <Team11B> If we both picked Box B last round why did we end up with A?
14:09:26 <Team11A> Let's just keep the boxes as equal as we can
14:09:32 <Team11A> and choose the one it transfers to
14:09:43 <Team11B> whooo 100 tokens
14:09:46 <Team11A> YES
14:10:21 <Team11B> ok I’ll make the boxes equal
14:10:25 <Team11A> Okay, make transfer?
14:10:28 <Team11A> yes
14:10:30 <Team11B> yes
14:11:36 <Team11A> so are we teamed up with another pair?
14:11:50 <Team11B> yeah we are playing against another pair
14:11:58 <Team11A> gotcha
14:12:14 <Team11A> oooooh the tension
14:12:20 <Team11B> haha yeah
14:12:39 <Team11B> ok so 'The Chooser is deciding between the two boxes' is that the other team?
14:12:51 <Team11A> I assume so
14:13:15 <Team11A> I thought we were doing it with each other but we always have the same screen up
14:13:41 <Team11A> so I'm assuming there is another pair that alternate in opposite role to us
14:13:46 <Team11B> yeah
14:13:58 <Team11B> again - I wish there was a practice round
14:14:07 <Team11B> this would have all been so much easier
14:14:12 <Team11A> same, or an example that they worked through
14:14:18 <Team11A> yay
14:14:23 <Team11B> :)
14:16:55 <Team11B> which one?
14:17:05 <Team11A> okay, do we go with B? or do you think there weren’t that many and it is better with A?
14:17:32 <Team11B> maybe B
14:17:39 <Team11A> okay, B?
14:17:55 <Team11B> Its so difficult to tell other people's strategy
14:18:00 <Team11A> I know ah
14:18:11 <Team11A> B
14:18:13 <Team11B> I’ve picked B
14:18:23 <Team11A> as have I
14:18:51 <Team11A> ah
14:18:56 <Team11B> not too bad
14:19:10 <Team11A> I got 45, did you get 45 or 75? I don’t understand lol
14:19:13 <Team11B> 45

14:19:18 <Team11A> oh gotcha
14:19:32 <Team11B> ok don't make the transfer
14:19:45 <Team11B> and pick box B
14:19:47 <Team11A> okay :)
14:20:01 <Team11A> I don't think we can choose a box, do we?
14:20:25 <Team11A> they choose the box they want and we get the other, right?
14:20:37 <Team11B> oh this is complex
14:21:05 <Team11A> We'll understand how to play the game when it's over lol
14:21:10 <Team11B> I have made the fair choice for both the teams
14:21:36 <Team11B> Box A contains 40 tokens and Box B contains 80 tokens
14:21:38 <Team11A> yeah, I agree
14:21:44 <Team11A> as fair as it could be
14:21:49 <Team11B> no point making it 30 and 90
14:21:58 <Team11A> yeah
14:22:19 <Team11A> hopefully they choose A though aha
14:22:37 <Team11B> fingers crossed yeah!
14:23:21 <Team11B> yay
14:23:22 <Team11A> yay
14:23:24 <Team11A> ahaha
14:23:35 <Team11B> they had a 50/50 chance
14:23:58 <Team11A> nice talking to you:)
14:25:31 <Team11B> same!
14:26:05 <Team11B> that was quite a short experiment
14:26:10 <Team11A> indeed
14:26:16 <Team11A> glad actually :)

Team 12

Table 121: Scenarios faced by team 12

Trial	Role	Scenario	P1 decision	P2 decision
0	P2	BS30	Transfer	DF
1	P1	SB35	No transfer	DT
2	P2	SB20	Transfer	DT
3	P1	BS20	No transfer	DT
4	P2	BS5	No transfer	DF
5	P1	SB10	No transfer	DT

13:56:38 <Team12A> hello
13:56:41 <Team12B> HI
13:57:18 <Team12B> Are you working on a transfer
13:57:37 <Team12A> no I'm waiting for the other team to decide if they are going to split
13:57:49 <Team12B> Okay, perfect
13:58:41 <Team12A> what do you think
13:58:59 <Team12B> Lets take box A?
13:59:12 <Team12A> sure
13:59:21 <Team12A> why box a
14:00:12 <Team12B> Because they won't transfer so many knowing if we select b they get a
14:00:25 <Team12B> A has to be better
14:00:29 <Team12A> fair enough
14:01:24 <Team12B> Do you want to make a transfer?
14:01:26 <Team12A> shall we make it?
14:01:34 <Team12A> yes
14:02:14 <Team12B> If we don't we at least get 40, but if we do then we have a chance of getting just 5
14:02:25 <Team12A> that's true
14:02:29 <Team12A> it's up to you
14:02:33 <Team12A> I don't really mind

14:02:40 <Team12B> Let's not make the transfer and see
14:02:48 <Team12A> okay
14:07:59 <Team12B> Lets take box b?
14:08:20 <Team12A> sure
14:09:46 <Team12A> good job
14:09:50 <Team12B> Great job!
14:10:21 <Team12A> don't make transfer?
14:10:23 <Team12B> Let's not make the transfer?
14:10:27 <Team12B> Perfect
14:10:27 <Team12A> sweet
14:14:19 <Team12B> Great job!
14:14:23 <Team12A> good good
14:16:54 <Team12A> erm
14:17:06 <Team12B> This a coin flip
14:17:26 <Team12B> You have any decision?
14:17:43 <Team12B> Lets take A?
14:17:45 <Team12A> a
14:17:50 <Team12A> yes
14:17:55 <Team12B> Perfect
14:18:54 <Team12B> Great job
14:18:54 <Team12A> its going well
14:19:32 <Team12A> no?
14:19:50 <Team12B> No transfer?
14:20:07 <Team12A> lets go with no transfer
14:20:12 <Team12A> yes?
14:20:15 <Team12B> Perfect
14:20:31 <Team12B> No transfer it is
14:20:40 <Team12A> is this the last one?
14:20:44 <Team12B> Yes
14:20:48 <Team12B> Probably
14:20:54 <Team12A> good good
14:21:10 <Team12B> All the best
14:21:45 <Team12A> we've done well in all of them so we should have an okay payment
14:22:02 <Team12B> Excepting the first 2
14:22:23 <Team12B> and don't know about this one
14:22:46 <Team12A> oh yeah
14:23:25 <Team12B> Ahh bad decision
14:23:28 <Team12A> hey ho

Session 3
Team 13

Table 122: Scenarios faced by team 13

Trial	Role	Scenario	P1 decision	P2 decision
0	P1	SB20	No transfer	DT
1	P2	SB35	No transfer	DF
2	P1	BS5	Transfer	DT
3	P2	BS20	Transfer	DT
4	P1	BS30	Transfer	DT
5	P2	SB10	Transfer	DT

15:11:59 <Team13A> hi
15:12:02 <Team13B> don't make the transfer
15:12:07 <Team13B> hey
15:12:08 <Team13A> I agree

15:12:10 <Team13B> cool
15:12:27 <Team13B> I selected it
15:12:37 <Team13B> what's your strategy?
15:12:44 <Team13A> I've clicked it as well
15:12:52 <Team13A> I don't really know what about you?
15:13:26 <Team13B> I'm thinking if we make a transfer they will obviously know which box to select. On the other hand not making the transfer will leave them with a 50 50 chance
15:13:57 <Team13B> let's see
15:14:01 <Team13A> yeah 50:50
15:14:10 <Team13B> good luck :)
15:14:11 <Team13A> its depends how much we are able to transfer in the trials
15:14:26 <Team13B> yeah because we couldn't change the amount right?
15:14:39 <Team13A> no but I guess it changes as the trials go on
15:14:49 <Team13B> I see
15:15:07 <Team13B> so we can't make a selection on the amount. the computer gives us the amount we can transfer
15:15:27 <Team13A> yeah the computer decides how much we can transfer, and then we have to decide whether to do it or not
15:15:33 <Team13B> okay got it
15:15:51 <Team13B> great :P
15:16:18 <Team13A> what do we do if they transfer
15:16:42 <Team13B> take it I think
15:16:56 <Team13A> you think they would be trying to trick us?
15:17:11 <Team13B> say if they transfer 20 from the 40 to 80
15:17:43 <Team13B> or 20 from the 80 to 40... it would still be 60 60 in each box. the thing is I don't know how they could trick us. That's what I'm trying to figure out
15:17:58 <Team13B> sure if they have a chance they will try to trick us but yeah I don't quite get how yet
15:18:25 <Team13A> they didn't transfer from a to b
15:18:32 <Team13B> so it's a?
15:18:35 <Team13A> so are we saying a has more in??
15:18:42 <Team13B> yeah I think so
15:19:07 <Team13B> unless of course they are trying to trick us
15:19:12 <Team13B> that would be unfortunate
15:19:15 <Team13B> :P
15:19:20 <Team13A> but either way it's no transfer
15:19:23 <Team13A> so it's still 40 or 80
15:19:38 <Team13B> it could be A has 40
15:19:43 <Team13B> and they denied the transfer of 35
15:19:44 <Team13B> u see
15:19:51 <Team13A> you choose
15:19:53 <Team13B> what do u think
15:19:55 <Team13B> A
15:19:57 <Team13B> I'm not sure
15:19:59 <Team13A> A it is
15:20:02 <Team13B> but let's go with A and see
15:20:09 <Team13A> I've clicked box a
15:20:11 <Team13B> same
15:20:20 <Team13B> damn it
15:20:29 <Team13B> just what I was afraid of
15:20:44 <Team13B> okay your turn to choose now :P
15:20:55 <Team13A> transfer
15:21:05 <Team13A> its only 5
15:21:07 <Team13B> yeah
15:21:10 <Team13B> cool
15:21:12 <Team13B> I agree
15:21:13 <Team13B> transfer
15:21:30 <Team13B> so transfer yeah- selected
15:21:31 <Team13A> cause even if they picked the 80 box we would get more than 40 as we have transferred

15:21:39 <Team13B> yeah
15:21:51 <Team13A> and we can scout out what they choose
15:21:56 <Team13A> they tricked us last time
15:21:59 <Team13B> yeah
15:22:53 <Team13B> so much waiting time
15:23:04 <Team13A> I know 60 seconds would be enough
15:23:09 <Team13B> agreed
15:23:25 <Team13B> think they might go with the 75 box again
15:23:32 <Team13B> wonder how they r thinking this
15:23:39 <Team13A> I think the other team know what they are doing haha
15:23:47 <Team13B> true :P
15:24:56 <Team13A> buzzing
15:24:59 <Team13B> congrats :)
15:25:04 <Team13A> well done
15:25:26 <Team13B> okay now we know they are trying to trick us
15:25:38 <Team13B> so let’s think as if we were Splitters and what we would do
15:25:42 <Team13B> maybe that helps?
15:25:45 <Team13A> I hope the value that can be transferred isn’t high
15:25:49 <Team13A> yeah let’s do that
15:25:50 <Team13B> hmmm
15:26:04 <Team13B> should be higher than 40... so then we know automatically :P
15:26:08 <Team13B> duh!
15:26:25 <Team13A> yeah!!
15:27:23 <Team13A> okay so say we are Splitters
15:27:46 <Team13A> if box a had 80 it would be a 60 b 60
15:27:54 <Team13B> lets go with box be because... if box be had 80, then it now has 100 and if it had 40 then both boxes have 60
15:27:55 <Team13A> but if box a had 40 it would be a 20 and b 100
15:28:04 <Team13B> :)
15:28:09 <Team13B> so box b?
15:28:13 <Team13A> perfect yeah
15:28:20 <Team13A> so we are either getting 60 or 80
15:28:24 <Team13B> yeah
15:28:28 <Team13B> I think we will be getting 60
15:28:30 <Team13A> 60 or 100 I mean
15:28:31 <Team13B> b right?
15:28:35 <Team13A> which is good
15:28:39 <Team13A> yeah box B
15:29:02 <Team13A> hope it’s 100
15:29:12 <Team13A> but I think it would be 60 60 cause I would do that as a Splitter
15:29:18 <Team13B> hope so but I wouldn’t get their logic if they chose that..
15:29:23 <Team13B> yeah I think so too
15:29:29 <Team13B> yeah there we go
15:29:31 <Team13A> yeah we were right
15:29:40 <Team13B> they’re playing well
15:29:41 <Team13B> grrr
15:30:01 <Team13A> if we transfer its 50 70
15:30:07 <Team13B> yes
15:30:12 <Team13B> as a Chooser what would u choose
15:30:28 <Team13A> if they transferred I would choose b
15:30:39 <Team13B> and if we don’t?
15:30:55 <Team13A> if they didn’t transfer I would choose a I think?
15:31:02 <Team13B> I think the question is do we want 50 or 40
15:31:19 <Team13A> I think transfer?
15:31:24 <Team13B> agree
15:31:29 <Team13A> ok transfer it is
15:31:34 <Team13B> perf
15:31:58 <Team13B> this is so unlucky they got it the better way, to transfer 35 from the lower one to the higher one
15:32:10 <Team13A> yeah we have the unlucky ones

15:32:19 <Team13B> it's okay we will make the best of it
15:32:24 <Team13A> either way if we transferred or not it would be them getting the higher tokens
15:32:34 <Team13B> yeah
15:32:50 <Team13A> hopefully they think we are tricking them and so they pick A
15:33:02 <Team13B> hahahaha
15:33:08 <Team13B> hope so u think that's possible
15:33:23 <Team13A> I doubt it but we can hope hahaha
15:33:25 <Team13B> if 30 is being transferred to which everyone, it would be the higher amount one
15:33:31 <Team13B> so they would be stupid to not choose it
15:33:32 <Team13B> hahahaha
15:33:35 <Team13B> yes we can
15:34:02 <Team13B> duh!
15:34:08 <Team13A> that was gonna happen
15:34:13 <Team13A> still 50 tokens though!
15:34:18 <Team13B> yeah exactly
15:34:50 <Team13B> 100 seconds
15:34:54 <Team13B> 90 seconds
15:35:08 <Team13A> so long
15:35:20 <Team13A> one minute left
15:35:33 <Team13A> is the 5th trial out of 6?? or is this 6? I've lost track
15:35:39 <Team13B> me too
15:35:42 <Team13B> maybe 5th
15:35:49 <Team13B> no idea
15:35:51 <Team13B> 30 seconds
15:36:00 <Team13A> I hope 6 lol
15:36:06 <Team13B> lol painful!
15:36:08 <Team13B> 15!
15:36:16 <Team13B> 10!!
15:36:32 <Team13A> 10 tokens
15:36:56 <Team13A> so it's either A 30 B 90 or A 70 B 50
15:37:07 <Team13B> yeah
15:37:18 <Team13B> I think A
15:37:23 <Team13A> I think A is risky
15:37:25 <Team13B> they might have made the transfer to confuse us
15:37:37 <Team13B> okay
15:37:51 <Team13B> B might give us a 90 or 50
15:37:52 <Team13A> B is either 50 or 90 whereas A is either 30 or 70
15:37:55 <Team13B> cool
15:38:03 <Team13B> B it is
15:38:04 <Team13A> B then?
15:38:09 <Team13A> b it is
15:38:34 <Team13A> yes!!!
15:38:35 <Team13B> GOOD!!!
15:38:37 <Team13A> they tried to trick us!!!
15:38:42 <Team13B> you're good
15:38:58 <Team13B> it was he 6th
15:38:58 <Team13A> what a good ending
15:39:01 <Team13B> agree
15:39:09 <Team13B> good job! it was fun playing with u
15:39:58 <Team13A> you're a good player
15:40:04 <Team13A> hopefully we get a good amount
15:40:24 <Team13B> fingers crossed good luck!
15:40:38 <Team13A> you too!

Team 14

Table 123: Scenarios faced by team 14

Trial	Role	Scenario	P1 decision	P2 decision
0	P1	SB20	No transfer	DT
1	P2	SB35	No transfer	DT
2	P1	BS5	No transfer	DF
3	P2	BS20	Transfer	DT
4	P1	BS30	No transfer	DT
5	P2	SB10	No transfer	DF

15:12:01 <Team14B> hi
15:12:04 <Team14A> hi
15:12:08 <Team14B> do you want to make transfer
15:12:44 <Team14B> ????
15:12:59 <Team14A> no not going to make the transfer a has 40 b has 80 tokens and transfer from a to b not worth it
15:13:12 <Team14B> so no?
15:13:18 <Team14A> no transfer
15:13:21 <Team14B> ok
15:14:43 <Team14A> so choose box B has 80 tokens and A has 40 tokens
15:14:56 <Team14B> yes
15:15:19 <Team14B> but we don’t have to choose right now
15:15:39 <Team14A> you have to choose b I think for max payoff
15:16:25 <Team14B> now it will be our turn to choose
15:16:43 <Team14B> every round we do either 1
15:16:51 <Team14B> so this round we choose
15:17:14 <Team14A> yes what's the transfer
15:17:22 <Team14B> not come up yet
15:17:47 <Team14A> Oh right got it
15:18:44 <Team14A> which box are you choosing?
15:18:57 <Team14B> should we choose B
15:19:17 <Team14A> hmmm
15:19:35 <Team14B> cause B HAD 80 AND A 40
15:19:40 <Team14A> I think choose b
15:19:42 <Team14B> QUICK
15:19:44 <Team14B> YES b
15:19:54 <Team14B> SO b?
15:19:57 <Team14A> yep b
15:21:07 <Team14A> transfer or not?
15:21:13 <Team14B> umm
15:21:18 <Team14B> it won’t make a big difference so either way is fine
15:21:27 <Team14A> so no transfer then?
15:21:35 <Team14B> okay
15:21:39 <Team14B> no transfer
15:22:01 <Team14B> no transfer done?
15:22:13 <Team14A> yep no transfer
15:27:42 <Team14A> which one do you think
15:27:58 <Team14A> I think choose b?
15:28:00 <Team14B> both have the same amount
15:28:08 <Team14B> so doesn’t matter
15:28:09 <Team14A> yep so choose b then ok?
15:28:14 <Team14B> okay
15:28:17 <Team14B> so b
15:28:25 <Team14A> yep
15:30:18 <Team14B> no transfer?
15:30:21 <Team14A> no transfer
15:30:27 <Team14B> yh no transfer

15:30:34 <Team14A>	cool
15:36:40 <Team14A>	choose A?
15:36:46 <Team14B>	yes
15:36:51 <Team14B>	A
15:36:56 <Team14A>	done

Team 15

Table 124: Scenarios faced by team 15

Trial	Role	Scenario	P1 decision	P2 decision
0	P1	SB20	No transfer	DF
1	P2	SB35	No transfer	DT
2	P1	BS5	No transfer	DT
3	P2	BS20	Transfer	DT
4	P1	BS30	Transfer	DT
5	P2	SB10	No transfer	DT

15:11:53 <Team15A>	Hey
15:12:11 <Team15A>	Should we transfer or not?
15:12:22 <Team15B>	not transfer
15:12:26 <Team15B>	I think
15:12:41 <Team15A>	yeah in case they choose box b
15:12:51 <Team15A>	cool
15:12:53 <Team15B>	it gives a better distribution if the other person picks box b
15:12:55 <Team15B>	yeah
15:13:06 <Team15A>	okay not transferring then
15:13:23 <Team15A>	but we could also get a 100
15:13:30 <Team15A>	maybe next round
15:13:36 <Team15B>	yeah
15:14:59 <Team15B>	if the Chooser knows how many tokens are in the boxes they'll always pick the larger ones
15:15:16 <Team15A>	Yeah but they don't know the values right
15:15:38 <Team15A>	I guess they'll assume we didn't transfer because A had a higher value
15:15:53 <Team15B>	yeah they don't I just asked
15:16:07 <Team15B>	lol we could have won 100
15:16:22 <Team15A>	But then they could've also picked Box B
15:16:47 <Team15A>	I think we're Choosers now
15:17:09 <Team15B>	yep
15:17:26 <Team15A>	If they transfer lets pick B
15:17:39 <Team15A>	Or even if they don't?
15:17:40 <Team15A>	Idk
15:17:43 <Team15A>	Confusing
15:18:29 <Team15A>	What shall we pick?
15:18:35 <Team15A>	Box A?
15:18:36 <Team15B>	let's do B
15:18:40 <Team15A>	Cool
15:19:07 <Team15A>	Try out luck
15:20:34 <Team15B>	dancing
15:20:41 <Team15A>	good choice!
15:21:08 <Team15A>	Let's not transfer
15:21:14 <Team15B>	yes
15:22:02 <Team15A>	If we are to lose the margin will be almost the same anyway
15:23:17 <Team15B>	I don't think we will lose though cause they think the same way we do, so they'll assume B was bigger
15:23:44 <Team15A>	Hopefully
15:24:01 <Team15A>	This way we may not make over 80 tokens in any of the rounds
15:24:31 <Team15B>	we can risk it all in the next round
15:24:47 <Team15A>	Yeah see what the trade off is

15:24:57 <Team15A>	Nice!
15:25:44 <Team15A>	This one will be tricky
15:25:56 <Team15A>	They may also get Box with more token
15:26:15 <Team15A>	box A with more tokens*
15:27:08 <Team15B>	I think we should take a risk when we are Splitters not Choosers
15:27:20 <Team15B>	*when
15:27:30 <Team15A>	What shall we pick?
15:27:35 <Team15A>	They made the transfer
15:27:38 <Team15A>	B?
15:27:45 <Team15B>	A is the safe option
15:27:57 <Team15B>	risk B?
15:27:59 <Team15A>	But the split is always 80-40
15:28:05 <Team15A>	So if they have transferred
15:28:09 <Team15A>	Either A will be more
15:28:12 <Team15A>	or equal
15:28:18 <Team15A>	B I mean
15:28:20 <Team15A>	Sorry
15:28:27 <Team15B>	no the last one was 75 -45
15:28:28 <Team15A>	Either B will be 100 or 60
15:28:35 <Team15B>	B
15:28:45 <Team15B>	pick b?
15:28:47 <Team15A>	But this is 20 right
15:28:51 <Team15A>	Yeah I think B
15:29:11 <Team15A>	B should be a safe one
15:29:13 <Team15A>	Pick B
15:29:20 <Team15B>	picked
15:29:30 <Team15A>	See
15:29:32 <Team15A>	equal
15:29:59 <Team15B>	that’s good
15:30:08 <Team15A>	What shall we do now?
15:30:15 <Team15B>	transfer
15:30:28 <Team15A>	Think we're going to lose this one anyway
15:30:33 <Team15B>	lol
15:30:48 <Team15B>	transferring now
15:31:01 <Team15A>	Are you sure?
15:31:25 <Team15B>	*transferring * I hope
15:31:30 <Team15A>	Okay
15:31:32 <Team15A>	Cool
15:31:34 <Team15A>	Let’s try
15:31:41 <Team15A>	But they'll pick B then
15:32:38 <Team15A>	They're picking B for sure
15:33:29 <Team15B>	fingers crossed
15:34:09 <Team15A>	See
15:34:32 <Team15B>	I've seen pick the last one
15:35:07 <Team15A>	Hopefully that trial doesn’t get selected
15:35:38 <Team15B>	yep
15:36:39 <Team15A>	What shall we pick?
15:36:41 <Team15B>	so B/A
15:36:54 <Team15A>	Either one could have more
15:37:07 <Team15B>	B?
15:37:26 <Team15A>	Idk
15:37:28 <Team15A>	Confusing
15:37:46 <Team15A>	Either one could have more
15:37:48 <Team15B>	what does your gut say
15:37:59 <Team15A>	Nothing lol
15:38:05 <Team15B>	lol B
15:38:09 <Team15A>	Okay cool
15:38:10 <Team15A>	B
15:38:22 <Team15A>	Chose it
15:38:28 <Team15B>	done

15:38:35 <Team15A> Nice!
15:38:38 <Team15A> Good gut
15:38:43 <Team15B> and from the ashes we rice
15:38:49 <Team15A> Haha
15:38:51 <Team15B> rise
15:39:11 <Team15A> Good work partner!
15:39:18 <Team15B> you too

Team 16

Table 125: Scenarios faced by team 16

Trial	Role	Scenario	P1 decision	P2 decision
0	P2	SB20	No transfer	DF
1	P1	SB35	No transfer	DT
2	P2	BS5	No transfer	DT
3	P1	BS20	Transfer	DT
4	P2	BS30	Transfer	DT
5	P1	SB10	No transfer	DF

15:14:02 <Team16B> should we pick Box A?
15:14:11 <Team16A> I think so
15:14:25 <Team16B> okay let’s see what happens
15:14:30 <Team16B> BOX A then
15:14:39 <Team16A> let’s try A yeah
15:16:40 <Team16B> should we transfer?
15:16:45 <Team16B> or not?
15:17:01 <Team16A> I don’t think so
15:17:04 <Team16B> let’s not transfer
15:17:07 <Team16B> yeah
15:17:26 <Team16B> and we'll hopefully get box B in the next round
15:17:46 <Team16A> yeah it’s too risky to just get 5 tokens
15:19:31 <Team16B> we should have taken the 80 tokens one in the first round
15:19:40 <Team16B> nevermind, from next time
15:20:12 <Team16A> but we didn’t know which one had 80 tokens?
15:20:24 <Team16B> it shows
15:21:07 <Team16B> oh yeah I don’t think it shows:/
15:22:55 <Team16A> what do you think
15:23:14 <Team16B> I don’t know :/
15:23:31 <Team16B> we're playing against a different team this time isn’t it?
15:23:36 <Team16A> yeah
15:23:55 <Team16B> let’s try B?;:/
15:23:58 <Team16A> yeah guess B
15:24:06 <Team16A> I have no idea
15:24:27 <Team16B> okay random guess B then
15:24:34 <Team16B> Box B
15:24:40 <Team16A> yeah
15:24:55 <Team16B> oh noooo
15:24:59 <Team16B> hahahha
15:25:07 <Team16A> ahaha
15:25:29 <Team16A> we should transfer
15:25:36 <Team16B> let’s transfer
15:25:37 <Team16A> all we have been getting is 40 before
15:25:44 <Team16B> yeahh
15:25:56 <Team16B> I’m sure they'll pick B if we transfer
15:26:10 <Team16B> and we'll get the 80 tokens
15:26:26 <Team16A> we would both get 60
15:26:33 <Team16B> oh right

15:26:35 <Team16B> 60
15:27:29 <Team16B> BOX A
15:27:44 <Team16B> we should pick the same option
15:27:54 <Team16A> yeah I thought that
15:27:56 <Team16B> oh sorry
15:28:09 <Team16B> the other team picks
15:32:13 <Team16B> let's take B
15:32:14 <Team16A> box b surely?
15:32:27 <Team16B> it's going to have either 80 or 70 <note: he means 70 or 110>
15:32:33 <Team16B> so Yes BOX B
15:34:50 <Team16B> let's not transfer?
15:35:01 <Team16A> I agree

Team 17

Table 126: Scenarios faced by team 17

Trial	Role	Scenario	P1 decision	P2 decision
0	P2	SB20	No transfer	DT
1	P1	SB35	No transfer	DF
2	P2	BS5	No transfer	DF
3	P1	BS20	Transfer	DT
4	P2	BS30	Transfer	DT
5	P1	SB10	Transfer	DT

15:11:40 <Team17B> hello
15:11:48 <Team17A> hi
15:11:54 <Team17B> shall we go for a or b?
15:12:03 <Team17A> I think we are Choosers
15:12:06 <Team17A> so we need to wait
15:12:14 <Team17B> oh yeah
15:12:17 <Team17B> sorry
15:14:00 <Team17A> there are either 40 or 80
15:14:00 <Team17B> right
15:14:16 <Team17A> my guess is that they had 40 in A
15:14:19 <Team17B> y
15:14:20 <Team17A> and didn't want to transfer
15:14:27 <Team17A> but just a guess
15:14:31 <Team17B> I say go for B
15:14:39 <Team17A> yes, let's do that
15:14:40 <Team17B> agree?
15:14:48 <Team17A> yes!
15:14:54 <Team17B> I've clicked B
15:14:59 <Team17A> same here
15:15:48 <Team17B> yes
15:15:51 <Team17B> got 80!
15:15:52 <Team17A> good job!
15:16:22 <Team17B> right we are transferring
15:16:27 <Team17A> don't transfer?
15:16:36 <Team17B> yeah
15:16:53 <Team17B> I've clicked no transfer
15:16:58 <Team17A> same
15:18:32 <Team17B> does the box we get depend on what the Choosers pick?
15:18:39 <Team17A> yes
15:18:46 <Team17B> thanks
15:18:59 <Team17A> but I am not sure if they get the info you see above the timer
15:19:08 <Team17A> or the fact that we did not make the transfer
15:19:42 <Team17B> they are the told the level we could have transferred and if we did or didn't
15:20:05 <Team17B> so they will know we refused to tranfer 35 tokens from A to B

15:20:23 <Team17B>	yes!
15:20:25 <Team17A>	yes!
15:20:29 <Team17A>	oh no
15:20:33 <Team17B>	what?
15:20:35 <Team17A>	or yes
15:20:39 <Team17B>	yes
15:20:40 <Team17A>	we got 80?
15:20:42 <Team17B>	yes
15:20:47 <Team17A>	good :D
15:20:54 <Team17B>	they went for Box A for some reason
15:21:01 <Team17B>	:P
15:21:07 <Team17A>	interesting strategy
15:21:23 <Team17B>	they probably overthought it
15:21:34 <Team17A>	true
15:21:35 <Team17B>	and tried to be sneaky but it failed
15:22:08 <Team17A>	yeah, I was thinking about that kind of reverse strategy but
15:22:18 <Team17A>	because we play against different people
15:22:26 <Team17B>	as long as we stay logical we should be fine
15:22:45 <Team17A>	it will be hard to catch
15:22:57 <Team17B>	I say A
15:23:04 <Team17A>	let’s go for A
15:23:09 <Team17A>	we are not losing much
15:23:18 <Team17B>	because it is only 5
15:23:24 <Team17A>	I agree
15:23:27 <Team17A>	I clicked A
15:23:31 <Team17B>	same!
15:24:41 <Team17B>	the wait is killing me :O
15:24:55 <Team17B>	yes!
15:24:59 <Team17B>	on it!
15:25:03 <Team17A>	we are on fire
15:25:04 <Team17A>	:D
15:25:12 <Team17B>	DREAM TEAM!
15:25:18 <Team17B>	(touch wood) :P
15:25:27 <Team17A>	will do!
15:25:46 <Team17A>	hm tough one
15:25:49 <Team17B>	I think go for it
15:25:57 <Team17B>	the boxes will balance at 60
15:26:01 <Team17B>	so it’s a win win
15:26:08 <Team17A>	yeah, it is a safe bet
15:26:17 <Team17A>	make transfer?
15:26:20 <Team17B>	yeah
15:26:22 <Team17B>	might as well
15:26:25 <Team17A>	done!
15:26:39 <Team17B>	because if we don’t they will go for A and we will get 40
15:26:58 <Team17B>	same done it
15:27:37 <Team17A>	too much waiting around...
15:28:01 <Team17B>	I know!
15:28:59 <Team17A>	and this round is not even exciting
15:29:29 <Team17B>	yes
15:29:33 <Team17B>	they went for A
15:29:36 <Team17B>	we did the right thing
15:29:37 <Team17A>	two more to go
15:30:03 <Team17B>	we are on a roll!
15:30:13 <Team17B>	gonna be balling at payment time :D
15:30:23 <Team17A>	fingers crossed we keep it that way
15:30:39 <Team17A>	haha yes!
15:31:59 <Team17B>	hmmmmmmm
15:32:13 <Team17A>	if they left only 10 in A
15:32:13 <Team17B>	this is tricky
15:32:18 <Team17A>	quite risky move

15:32:28 <Team17A> I say we should play safe and go for B ?
15:32:32 <Team17B> yeah
15:32:35 <Team17B> deffo
15:32:44 <Team17B> I've clicked B
15:32:49 <Team17A> me too
15:33:11 <Team17B> because if 80 is in A, then B goes up to 70
15:33:28 <Team17A> I can't see why they did that transfer
15:33:36 <Team17B> same
15:33:37 <Team17A> cause in any way B will have more
15:33:40 <Team17B> B is a win win
15:34:10 <Team17B> done it right again!
15:34:16 <Team17B> one more to go
15:34:17 <Team17A> I guess they thought better win 50 than 40 :D
15:34:24 <Team17B> true!
15:34:33 <Team17B> hmm
15:35:04 <Team17B> we could confuse them and transfer the tokens
15:35:11 <Team17A> that's what I was thinking
15:35:16 <Team17B> because it is only 10
15:35:16 <Team17A> and it is the last one
15:35:22 <Team17B> let's do it!
15:35:24 <Team17A> we might as well play it risky
15:35:25 <Team17B> transfer
15:35:29 <Team17A> yes!
15:35:44 <Team17B> we seriously slayed this game! :P
15:36:02 <Team17A> agree!!!
15:36:18 <Team17A> hope we have luck with payout cause they will randomly pick a round
15:36:37 <Team17B> same
15:36:43 <Team17B> but all of ours so far have been high
15:36:47 <Team17B> so we should be fine
15:36:53 <Team17B> the lowest was 60
15:37:11 <Team17B> unless this one goes wrong
15:37:17 <Team17A> true, it will be really bad luck if this one is 30 and then with chance 1/6 we get it :(
15:37:34 <Team17B> :*(
15:37:36 <Team17B> it would
15:37:44 <Team17B> got too cocky
15:37:48 <Team17B> but you never know
15:38:02 <Team17A> haha well the way I see it
15:38:11 <Team17A> it is always extra money
15:38:23 <Team17A> even with bad luck and little payment :D
15:38:26 <Team17A> moment of truth
15:38:35 <Team17A> nooo
15:38:35 <Team17B> shit!
15:38:44 <Team17B> it doesn't matter
15:38:45 <Team17A> oh well, fingers crossed
15:38:53 <Team17B> what is the highest we got?
15:38:58 <Team17A> 80
15:39:08 <Team17B> fingers crossed
15:39:30 <Team17A> :)

Team 18

Table 127: Scenarios faced by team 18

Trial	Role	Scenario	P1 decision	P2 decision
0	P2	SB20	No transfer	DT
1	P1	SB35	No transfer	DT
2	P2	BS5	Transfer	DT
3	P1	BS20	Transfer	DT

4	P2	BS30	No transfer	DT
5	P1	SB10	No transfer	DT

15:11:51 <Team18B> hi
15:11:58 <Team18A> hi
15:12:12 <Team18A> we are the Chooser right?
15:12:19 <Team18B> yeah
15:12:30 <Team18B> don't need to do anything yet
15:13:10 <Team18B> did he say 1 box always has 80 and the other always 40 at the start?
15:13:16 <Team18A> yeah
15:13:21 <Team18B> kk
15:13:25 <Team18A> in every trial
15:13:36 <Team18B> yeah
15:14:03 <Team18A> so they decide not to do any transfer
15:14:25 <Team18B> yeah
15:14:26 <Team18A> I can think is because box A had initially the 80 maybe?
15:14:38 <Team18A> or they tried to fool us
15:14:58 <Team18B> but maybe they wanted to keep them as even as possible if A had 40
15:15:07 <Team18B> I say we go for A
15:15:12 <Team18B> the minimum can be 40
15:15:23 <Team18A> I think they were not taking that risk. My bet is the 80 are in the B box
15:15:33 <Team18B> actually yeah I agree
15:15:36 <Team18B> lets go B
15:15:37 <Team18A> ok choice b
15:15:49 <Team18B> nice
15:15:52 <Team18A> yuhuuu!
15:16:33 <Team18A> hmm
15:16:37 <Team18B> I say no transfer to keep a fair balance?
15:16:49 <Team18A> agree
15:17:01 <Team18A> do not transfer
15:17:17 <Team18B> yeah pressed it
15:17:28 <Team18A> same
15:17:44 <Team18B> its different people this time so maybe they won't use the same reasoning and go for A hopefully
15:20:42 <Team18A> not too bad…
15:21:22 <Team18B> yeah 40 is fine, unless later we want to try a bluff
15:22:56 <Team18A> ufff
15:23:14 <Team18A> could be everything, 50/50
15:23:43 <Team18A> which one you want to pick?
15:23:56 <Team18B> if we go for B and it started at 40 its now 45 and if it started at 80 its 85, a is either 35 or 75 so I say go B
15:24:03 <Team18A> ok B
15:24:21 <Team18B> yup done
15:25:37 <Team18A> if we transfer we win 60 anyways
15:25:50 <Team18B> yeah which is pretty good, so do it?
15:26:38 <Team18A> if not we can try to tease them, they will think a had initially 40 so we were not taking a risk
15:27:03 <Team18B> yeah could do
15:27:08 <Team18A> well I press transfer
15:27:12 <Team18B> same
15:27:15 <Team18B> leave on transfer
15:27:19 <Team18A> yes
15:27:37 <Team18B> but if we have a similar one next time we can try that
15:27:43 <Team18A> yes
15:32:43 <Team18B> any ideas
15:32:46 <Team18A> I think they were conservative and didn't leave a with only 10
15:32:58 <Team18B> so you think a is 40?
15:33:08 <Team18A> I think b is the 80…
15:33:22 <Team18A> what do you think?
15:33:22 <Team18B> okay let's go b then

15:33:25 <Team18A>	ok
15:33:29 <Team18B>	yeah I think you’re right
15:33:36 <Team18A>	hah well we don’t know
15:33:44 <Team18A>	they might played a bluff here
15:33:44 <Team18B>	we will see I 10 seconds
15:33:53 <Team18B>	yeah but we can’t know that
15:34:03 <Team18A>	argg
15:34:05 <Team18B>	it was a bluff
15:34:05 <Team18A>	hah
15:34:08 <Team18A>	yep
15:34:09 <Team18B>	never mind
15:34:34 <Team18B>	now because this is the last round do we bluff or do we double bluff?
15:34:47 <Team18A>	double bluff?
15:35:05 <Team18A>	10 tokens is little amount to bluff... but as you want
15:35:07 <Team18B>	so stay the same because they will be expecting a bluff
15:35:19 <Team18A>	alright
15:35:31 <Team18A>	so not make transfer then?
15:35:52 <Team18B>	yeah don’t make the transfer
15:35:57 <Team18A>	ok

Appendix 3: Suitcase Game

Appendix 3.1: Instructions for participants

This appendix provides the reader with a summary of the instructions participants received through a PowerPoint presentation. In line with the wording of Chapter 4 we refer to P1 as ‘Splitter’ and to P2 as 'Chooser' during the experimental session.

<u>Slide 1: Title slide with a suitcase image</u>

Hello everyone, today we are playing the suitcase game. I will explain the task using a PowerPoint presentation. At the end of the presentation you can ask questions if anything is unclear. Now, how things work.

<u>Slide 2: How things work</u>

Every trial you are matched with another player who plays a different role. One participant is called the ‘Splitter’ whilst the other is called the ‘Chooser’. In this game the Splitter receives a suitcase which has a certain amount inside; and his task is to decide how much value to take from the suitcase and place it on the table. The other player, the Chooser, can see how much value is placed on the table but he does not know how much remains in the suitcase. The task for the Chooser is to decide whether he wants the amount on the table or the (unknown) amount in the suitcase.

<u>Slide 3: Knowledge (this slide is only used for the sessions with AVs)</u>

Before the suitcase is opened, both players – Splitters and Choosers – share the same information about the total amount of money that is to be divided. Either both players have no information on the total amount; or both Splitter and Chooser are informed of two possible values, one of which will be **randomly** chosen (by the computer) to be placed inside the suitcase. (Both amounts are equally likely to be chosen and both players see the same amounts).

So for example, the possible values may be four and six. This means that both players know that the suitcase will contain either four or six tokens.

When the suitcase is opened the Splitter finds out what the actual amount inside the suitcase was. In our example the suitcase contains six tokens.

e.g. 6 = **Actual value**: The suitcase contains 6 tokens.

Slide 4: Notes

Next, I discuss some important things to know about the experiment. Firstly, every trial your role switches between being Splitter and Chooser; thus if you start as Splitter you are then choose, Splitter Chooser etc. If you start as Chooser you are then Splitter, choose, Splitter etc. Secondly, you are randomly matched with another player on every trial. So you do not play the same person throughout the experiment; every trial you are randomly rematched. Finally, feedback is provided at the end of each trial. Feedback consists of a summary of what option you won (the suitcase versus the table) and how many tokens this option provides; furthermore, you are given feedback on the option that the other player won and how many tokens this provided him.

As I already mentioned this experiment uses **tokens** as its currency. Now, what are tokens? Tokens are like pounds but you do not know their value. At the end of the experiment the conversion rate (from tokens to pounds) is revealed. The amount of tokens you earn on a randomly selected trial will eventually decide your performance fee.

Now, the payment. For participating in the experiment you receive a participation fee of two pounds; you receive this just for participating to the experiment. And furthermore, you receive a performance fee, between zero and ten pounds; depending on the amount of tokens you earned in a randomly selected trial. So it is not the average amount you win across trials, we **randomly** pick one trial and assess performance solely on that trial to decide your performance fee.

Slide 5: Sequence of events for each trial

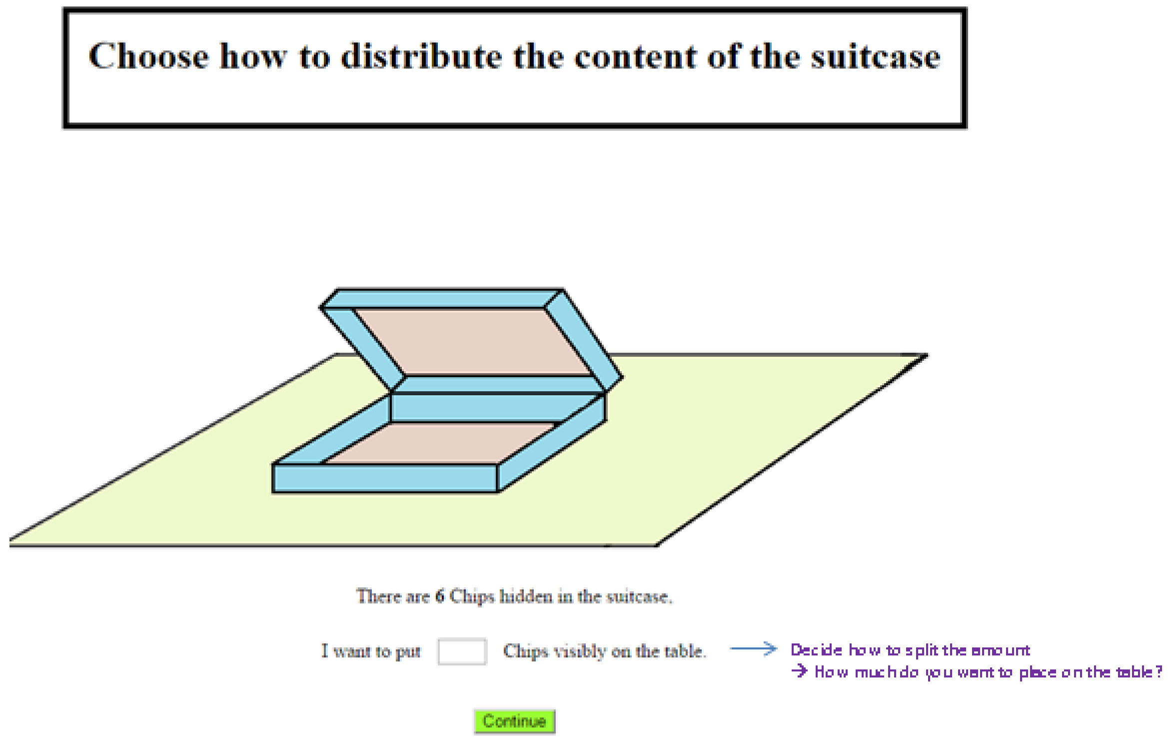
We summarize the sequence of events for each trial. First, you may be provided with information regarding two possible values for the suitcase. Then, the Splitter opens the suitcase and finds out its exact value. His task is to decide how much value to place on the table. Next, the Chooser is told how many tokens are placed on the table and he chooses between the amount on the table and the (unknown) amount in the suitcase. And finally, feedback is provided.

Slide 6: Splitter screen

Next, I will illustrate how the task looks like using some screenshots. As Splitter you see the following screen. The knowledge of the suitcase is first displayed. This means that both you and your matched player know that the suitcase will contain one of the following amounts; for example six or eight chips. The screen has a button saying 'open the suitcase' which you then click to continue.

Slide 7: Deciding how to split:

After clicking the button you are asked to distribute the content of the suitcase. You find out that six chips[93] are hidden in the suitcase and you type a number to indicate how many chips you want to transfer to the table. This has to be an integer number (thus not something like 1.2345 or pi) but any integer amount including zero and the full suitcase value are allowed. Once you decide upon the transfer amount you simply click on the 'continue' button to finalize your decision.



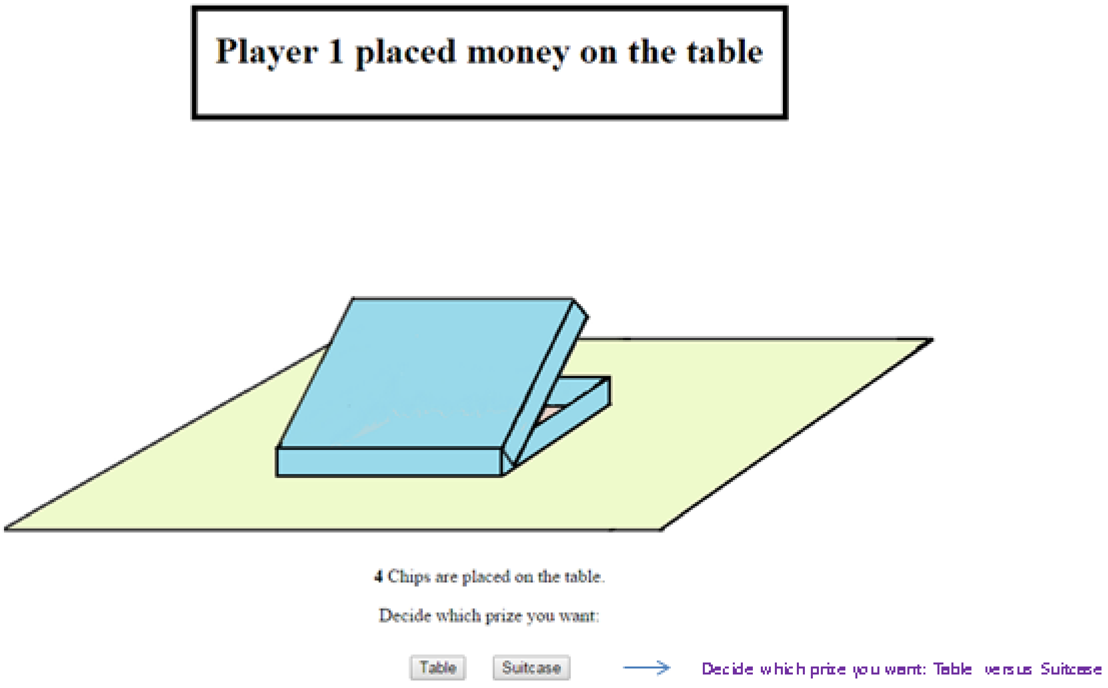
[93] We use 'chips' for practice trials and for the example to avoid misconceptions about representativeness for the actual experiment.

Slide 8: Chooser screens

As Chooser you are informed of the same prior information as the Splitter receives: namely that six or eight chips are found in the suitcase. Once you read this information you can click the 'continue' button to move to the next stage. You will now see a waiting screen until the Splitter makes his decision at which point you see the following screen. (see slide 9).

Slide 9: Chooser decision

The screen says that player one made his choice and placed four chips on the table. Of course this is a hypothetical example and you will see different amounts during the actual experiment. You decide whether you want the table or the suitcase value by clicking the corresponding button. Afterwards feedback is provided and then we wait on everyone to finish the current trial before randomly matching you with another player.



Slide 10: practice trials

We start off with two practice trials. These trials do not affect your pay-off; they are solely to get familiar with the task. Furthermore, the amounts in actual trials involve 'tokens' as the currency whilst practice trials use 'chips'. It is important to know that the amounts that are won in both sessions are unrelated. Are there any questions before we continue?

(pause)

Then I will now start the practice trials. If there are any questions during the experiment simply raise your hand and I will come to you.

Appendix 3.2: Cheap talk exploration

After our first session we did a short pilot of a "cheap talk" variation. This happened during pay-off calculation and was unrelated to any monetary incentive. In this variation the Splitter was allowed to choose one of seven messages to send to the Chooser. There was also the option of "not sending a message". From the perspective of many common theories (e.g. Nash) Splitters should not bother with sending messages and Chooser should just ignore it when a message is send to them as their interests diverge. Psychologically, however, we can imagine how participants would be tempted to try and trick their counterparts.

Our data on this small pilot comprises of only 24 unique trials altogether and are thus to be seen as an *exploration* of the variation. In Table 128 we summarized all messages that were available and what frequency they were selected.

Table 128: Messages in cheap talk pilot and their frequency

I made you a fair deal	7
I made you an unfair deal	1
Let us be nice to each other	2
I wish you luck	3
I put the bigger amount on the table	3
I suggest you to take the amount on the table	2
I suggest you to take the amount in the suitcase	4
I do not want to send a message	2

All messages have been used at least once. Twice was chosen not to send a message. The messages that have been sent can generally be placed under certain categories. One such category is Being Nice (fair deal, be nice, good luck). A second category is Nudging (the bigger amount is X, I suggest X). Finally, you have a Being Bad category (unfair deal).

One interesting observation is that people always split equally when they opted for “let us be nice to each other”. This message may be chosen for those who expect reciprocity (even though matchings are made randomly on every trial). They seem to say: “let us play nice, look what I did, I split equally, now you do the same”. A somewhat similar result shows up when people say that they “split fair”: five out of seven observations are equal splits, one was with a two token difference and one was unfair but with 45 (quite a high amount) tokens on the table. No other messages had an equal split!

On all three trials where “I wish you luck” was opted no information was available. Twice a relatively large chunk was on the table and slightly more was hidden in the suitcase. Once the amount to be divided was relatively small and the biggest part was placed on the table. This may mean that the message can be used for displaying a “hidden un-niceness”: I seem to split nicely but am still trying to trick you in taking the smaller chunk.

The claim to be unfair is a weird one. Why would you want to tell your opponent that you try to trick them? It seems somewhat odd of a message and was selected only once. The split on this trial was 40 – 2. As the numbers in this pilot were the same as those from the real experiment played before participants would know that 40 is quite a high number to be displayed on the table. Thus, this truthful message may have been an attempt to trick the opponent in having a tiny prize or it may be a give-away as no monetary incentive was linked to these pilot trials. The Chooser ended up with the bigger prize on this trial.

Finally, when a suggestion was made advice was sometimes followed and sometimes ignored. The advice was followed more often when there was information on the potential values and ignored more often when no information was available. This may be a finding or it may be an artefact from our small number of trials.

Overall, it seems like a Cheap Talk variation may be interesting to explore more deeply with a lower variety of messages to choose from – or perhaps with non-textual messages (f.e. a hand pointing to a pile of gold on left or right hand side and a neutral thumbs up message).

Appendix 3.3: Within participant comparison of equal division behaviour

In Table 129 we assesses the frequency in which each unique P1-participant decides to divide the distribution amount in equal halves. A comparison is made between his four trials with AVs and his four trials without AVs. We assigned a 'green' background colour to individuals who make more equal divisions when AVs are provided than when they are not provided and an 'orange' background colour to individuals who display the opposite tendency. The 'blue' background is used whenever individuals made equal divisions equally often in the two conditions.

Table 129: Within participant frequencies of making equal splits across information conditions

Participant	Information	No Information
0	0	0
1	2	1
2	0	0
3	4	0
4	0	0
5	4	4
6	2	0
7	0	1
8	0	0
9	1	0
10	4	4
11	0	0
12	3	0
13	2	1
14	4	4
15	3	2
16	3	4
17	1	0
18	4	1
19	0	0
20	4	1
21	2	0
22	4	4
23	4	1
24	3	1
25	1	0
26	3	0
27	3	0
28	4	1
29	2	0
30	1	0
31	2	0
32	3	0
33	2	3
34	2	2
35	4	0

There are eleven P1s who made equal splits equally often in both conditions (blue coding) whilst twenty-two P1s made equal splits more frequently in the condition with additional knowledge (green coding). Three P1s made equal divisions more frequently in the condition without AVs (orange coding). It is worthwhile to note that these same three individuals made at least once an error against dominance when AVs were provided.